

Lesson Plans

Section 1:

On Detecting

Section Summary

Duration

4 – 5 hours

Storyline

This section sets the stage for the *Detective Agency* to happen. Mysteriously, an unexpected visit from a detective (you, or another “actor”) triggers an interest in detecting, or seeing with one’s hands. How can a detective see in the dark? Can s/he? How can one get good at seeing with hands, with chairs, or in other unusual ways? Many ways to gather information are explored as challenges involved in becoming a detective.

Students are asked to become detectives and look for things previously unseen. They look for ways to see differently even as they establish themselves as detectives in a detective agency, and begin to think of themselves as detectives. The physical characteristics of your classroom’s agency are established here.

Math Purpose

Lesson 1-1: Seeing with Hands

To introduce the *Detective Agency* as a math setting for the classroom, and to be able to identify 3-D objects using only the hands

Lesson 1-2: Seeing Too Much

To sharpen observation skills by making a prediction, conducting an experiment to test the prediction, graphing the data collected, and interpreting the results.

Lesson 1-3: Seeing Through Shape

To inquire into square numbers (1, 4, 9, 16, ...) and their relationship to squares.

Lesson 1-4: Seeing with Chairs

To review 2D shapes, and qualitatively compare perimeters of table tops with different shapes.

Lesson 1-5: Seeing Through Arms and Legs

To compare the length of line segments situated in different contexts.

Math Objectives (Alberta Education)

Identifies 3-D objects by using the hands alone, conducts experiments and collects data to test hypotheses, uses a scale model to make inferences about the real world, uses problem-solving to estimate the perimeter of various polygons.

Specifically,

- G8** classifies 3-D objects by using objects to name prisms, pyramids, cones, cylinders, spheres
- D4** conducts experiments
- D13** constructs graphs
- P21** does a simpler but related problem (constructs a model)
- M14** estimates, measures, compares and orders length
- M44** uses manipulatives and diagrams (no formulas) in a problem-solving setting to find and compare the perimeter of polygons.

Materials

In the kit:

- *Detective Agency* **Kodak Photo-CD**
- **Polygon Cutouts**
- **Squared Flathead Grids**
- **Triangled Flathead Grids**
- **Bulletin Board Bag**

Letters: 26 letters

Titles: *Agency Note Board*, *Thought of the Day*

Poses: a surveillance scene

a magnifying glass examination of a set of fingerprints
a wanted poster

- **Poster:** Agency License
- **Résumé Folders**
- Licenses for the detectives, with plastic holders

You provide:

- geometric solids, at least two sets
- 5 or 6 cloth bags
- squared paper for graphing
- chart paper and pens
- measuring tools
- "ink" for fingerprinting

Preparation

1. Gather resources related to setting the scene and establishing the *Detective Agency* in your classroom. For example, at some time during this section you might:
 - a. Bring out (or make) some bulletin board displays that feature detectives or mysteries, such as:
 - Put up riddles or mysterious events (pieces) on cards, and provide hints as to their explanation on the underside or in another location that needs to be detected with, perhaps, a few leading clues
 - Create mystery treasure maps or suggest students do so
 - b. Post newspaper and magazine clippings that feature scientific or geographic mysteries such as black holes, mysterious markings in farmers' fields, UFOs, quarks, the behaviors of light, or any unsolved scientific mysteries that you or your students might come up with
 - c. Set out some of the books from the **LitFile** in one section of the room, as an invitation to explore topics inherent in the work of detecting/investigating
 - d. Post a partial list of mystery or detective books, both fiction and non-fiction, close to your classroom door, where the students (detectives) will notice as they are off to the library
 - e. Plan ways to have a few mysteries happen in your classroom. For example, a large chocolate cake could suddenly appear, or a message you are planning to send receives an answer before it is sent
 - f. Leave some exaggerated footprints or fingerprints on a classroom windowsill
 - g. Find an animal (stuffed or real) that could be an Agency mascot
 - h. Come to school in some borrowed clothes that are not usual for you: a disguise
 - i. Set out some old and tattered clothing; why is it tattered?
 - j. Wear a slouchy hat, and "Sherlock Holmes" gear; come dressed as a detective the students would recognize
 - k. Bring in a plant, ornament, or object that is unrecognizable
 - l. Arrange a visit from a private investigator or police detective
 - m. Play some mysterious or haunting music

Add to these ideas as you go along. This section (and the next ones, as well!) can be very rich in mysterious and detecting experiences/happenings. You might enlist other staff, parents, or the students themselves to help you, as appropriate.

Connections

Assessing and Monitoring

Periodically enter remarks about student interest and mathematical behavior in the **Events-Based Record-Keeping Charts** (**Copy Master INTRO.F: Events-Based Record-Keeping Chart**), especially at the end of the section. As well, keep track of:

Assessment in Context: Many of the activities in this section relate to being creative about seeing in different ways. As well, students create their own materials to do so. Assessment here could be done by noticing and making anecdotal comments about student attitudes and care in their explorations. For example, noting the care with which the instruments are prepared in Lesson 1.3 may be illuminating.

Recordkeeping: Update both Objectives-Based and Events-Based Record-keeping Charts

Student Self-Assessment: Students could be asked to give an oral description of what it means to see in different ways and how well they feel they are able to do it.

Files

- **ParentFile:** Send home the introductory letter or an amended version of it as an introduction to the unit. You may want to include some indication of your plans, and if appropriate, information about a field trip.
- **LitFile**
- **ComputerFile**
- **PSFile**

Ongoing Events

Formal Assemblies

- to present some "dramatic event" (e.g. a recent mystery)
- for "Looking Back" sessions to share and discuss problem solving solutions
- to present important information, a problem for discussion, mini-lessons or guidance, a new piece of the storyline, etc.
- to provide a democratic forum for resolution of problems of all kinds, including such dilemmas as social problems (people not getting along), division of labor (someone not pulling his/her weight in group work), clarifying roles and responsibilities (getting into character), etc.
- to make "Mathematics as Communication" come alive in your classroom

Spontaneous Assemblies: as needed

Agency Note Board and Assembly Agenda: A section of the chalk board or a laminated poster to announce the intention to meet and the reason or expectation:

- announcements of Assembly times
 - expected visitors
 - presentation times
 - any *Detective Agency* news
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The Bulletin Board Bag supplies a title for you to post and **Copy Master Intro.D: Assembly Agenda** is available for making an official Assembly announcement.

Some suggestions:

A full day's agenda could be posted, if you have one. It could include all the days' activities at the agency, including meeting times.

Mysterious Solids: After Lesson 1-1, students may work with identifying bagged solids of various kinds; they may develop the activity into a game. They could select objects that might make the "seeing with your hands" difficult and then challenge a partner to ascertain the difference. Exploration and discussion will increase observation skills and familiarity with the attributes of the geometric solids. Naming them could become another aspect of the game or challenge. See Lesson 1-1 for further suggestions.

Seeing with Memory: Throughout Section 1, set up impromptu situations in which students are asked to remember something they have been seeing. This could be something that has been in the room continuously for some time and which you remove. Then ask them to recall the details of it, or it could be something you allow them a certain amount of time, such as 10 seconds, to look at, then remove and ask them to recall the details or composition of the set. This activity can take a multitude of variations, and may continue into Section 2 and the rest of the *Module* if interest persists. Some suggestions are given at the end of the lessons in Section 1. Suggest that students create their own versions and share them with the class.

In-Between Cases: Area

DMP* (Measurement Division II) provides two activities which would be excellent ways of following up the area ideas introduced in this section.

- **Amazing Area II** (pp. 142-148) provides experience with using non-standard units to find and compare areas:
 - Exploring Area Units*
 - Focusing on the Square Unit*
 - Relating Area to the Size of the Area Unit*
- **Amazing Area III** (pp. 149-155) provides three activities, only the first of which is appropriate at this time. It is **Activity A: Different Shapes with the Same Area**
 - **Note:** While DMP is primarily designed as a tool to integrate diagnosis with instruction, the learning activities in the program are also excellent as instructional activities in their own right. Accordingly, those activities in DMP that are particularly fitting at certain points in the Detective Agency are identified as a means of enrichment and extension.

In-Between Cases: Finding Perimeter

DMP (Measurement Division II) has materials for making two perimeter activities that extend the ideas in this case:

- **Perimeter Power II** involves finding the perimeter of various objects using nonstandard units (pp. 131-132)
- **Perimeter Power III** involves finding the perimeter of various objects using standard units (pp. 133-137). This activity is in particular connected to the ideas in this case (**Lesson 1-4**)

Résumé: Accumulate résumé information inside the **Résumé Folder** throughout the *Module* in preparation for the culminating event: the accumulating notes/notations of expertise, records of seeing, *Seeing with Memory challenges*, etc.

Ask Me Logbook: Write regularly about *Detective Agency* happenings: arrival of a mysterious detective, searching for ways of seeing, the development of detecting skills, and/or designing their space

Student Problem Book: Notice that part of the culminating event is the presentation of problem(s)/cases. Students may begin early and continue throughout the *Detective Agency* to create and record mysterious happenings and challenging cases to solve. These may be exchanged with a partner who tries to find the solution(s), or they may become discussion instruments in pairs or small groups, or at larger assemblies, as time permits. Encourage creativity.

Student Dictionary: Ideas in **Appendix H: Illustrated Math Dictionary**

Integration Opportunities

STS Issues

- **Surveillance:** When does undercover surveillance become intrusion of privacy? To what lengths should investigators be allowed to go? Should wire-tapping be allowed? By whom? When? Why? (Zonderman, 1990)
- **Information Control:** "Detective discretion lies in information control: the investigations they do or do not undertake; the questions they do and do not ask; the interpretations they do and do not give to the answers; the written accounts they give and what they leave out; the formulations they give to other actors and their ability to predict that these will be routinely accepted by others as legitimate for purposes of action" (Ericson, 1991, p. ix). What information should be controlled/released?
- **Mass Testing and Civil Liberties:** Should people be required to give personal information about themselves? Take tests such as a breathalyzer, or be fingerprinted? Should governments be allowed to require tests for certain groups, such as AIDS testing for the military? (Zonderman, 1990)
- **Security for the investigator:** What measures would be reasonable for an investigator to take in order to protect him/herself? Is being a detective a high-risk profession? Why?

See also: **Appendix G: References and More Resources**

Science

- **Tools of Science:** Examine and use any scientific instruments available in your school. This may be a time to use microscopes to examine pond water, or a time to think of how to measure distances to the stars.
- **Forensic Science:** How is science used in the discovery of information? Hands, feet, lips, paint, glass, tire tracks, hair, blood ... (Breckon, 1975)
- **Genetic Fingerprinting:** Examine genetic fingerprinting as well as ordinary finger printing as a form of evidence. (Breckon, 1975, Millimaki, 1976, Zonderman, 1990)
- **The Scientific Approach**
Approach problem solving in science as a process of detecting
Identify mystery powders or liquids
Use microscope and magnifying glasses to analyze evidence

Computing: The design of computers and their space in offices (ergonomics), and some of the difficulties associated with computer use such as lighting and distance from monitors, could be explored in relation to the design of office/classroom space. How could computers be efficiently used and accessed by each student in a classroom that has little more space than the desks themselves take up?

Language Arts

- **Detective literature:** Establish a "language of detecting" through reading detective literature, as well as modeling behavior of good detectives
- **Mystery Stories:** Talk about mystery stories and how they are written. Have your students write some of their own
- **Novel studies:** Novel studies could be based on the detective genre. Encourage students to:
Interpret their reading of mystery novels in terms of the problem-solving model
Examine and identify characteristics of a good detective in mystery novels
Examine the author's ways of creating the "mood of mystery" in his/her detective story.
- **Story Writing:** Write mystery stories based on Polya's problem-solving model:
Understanding the problem
Deciding a strategy
Carrying out the strategy
Looking back
- **Writing conferences:** Do writing conferences based on a writing conference model
- **Planning:** Develop plans to organize investigation of new ideas, information and experiences
- **What-ifs:** metaphor, simile, hyperbole. Write "what-if" scenarios
- **Debate:** Defend or support opinions such as your students' table arrangement decisions in a formal presentation or debate setting

Fine Arts.

- **Sketching:** Excellent practice in seeing.
- **Color:** Mix colors from component colors —as another way to see
- **Finger print art:** Create art through finger prints
- **Storytelling:** Mysteries, cases to solve, etc.
- **Creating Labels and Bulletin Board Displays:** Multi-media possibilities
- **Crafts:** Exploration can come out of discussion of the need for precision in tool use, in tools themselves, and in the reporting process

Health.

- **Careers:** Developing résumés and presentation skills can be extended into a variety of career applications
- **Social Problems:** Using the problem-solving model to help solve social problems or conflicts

Mathematics in This Section

Although this section is primarily intended to develop both the mystique and the practicality of a detective agency, a number of mathematical concepts emerge from the activity of setting up an agency and engaging in “detecting” behaviors, such as making careful observations, recording these systematically, and seeing patterns in the recordings.

A Note on Pattern Blocks:

Pattern blocks are used in a special way in this section. Most often they are used to construct interesting and colorful geometric patterns of various sorts because the pieces fit so nicely together – mathematically speaking they “tessellate.” They tessellate nicely because the length of the edges of every piece is the same or is a simple multiple of a standard length. For example, if the triangle is said to have edges of length 1, then so does the square, the rhombus, the parallelogram and the hexagon. The trapezoid has 3 sides of length 1 and one side of length 2.

These standardized lengths that match so nicely can be used in a special way to “qualitatively” measure perimeter. In this section, the pattern blocks are taken as model table tops to be used in solving a client’s problem. In this role, the triangle piece is a “three chair table”, the square is a “four chair table”, the trapezoid a five chair table — and of course their perimeters are in a relationship of 3 to 4 to 5.

If more complex arrangements are made by putting tables together (and these pieces go together so nicely) to make a big table, each can be qualitatively quantified as being an “n chair table.” This descriptive naming would be a way of descriptively specifying perimeter.

Additionally, other mathematical concepts arise when students:

- Test out the keenness of their observational powers, while using only their hands to identify attributes of 3-dimensional solids
- Assess their ability to observe commonplace events by predicting the occurrence of such events, then assess their predictions by conducting an experiment and graphing the results

Teaching in This Section

To begin seeing themselves as detectives, students in this section look extensively at the characteristics and skills of detectives/investigators. The Lessons help them expand their view of "seeing." *Lesson 1-5* ends with the detectives receiving an *Agency* license for their classroom, and individual agent licenses for themselves. They are also asked to begin a résumé by completing the information asked for in the **Résumé Folder**, and discussing what information could be included in the résumé and how it could be organized. Many **Ongoing Events** can be incorporated into this résumé-making. In Section 2, students are asked to think about reporting their work.

Depending on the sophistication of your class regarding the contents and organization of a résumé, you will need to guide them in its construction. To help summarize and remind, make point-form wall charts that can be added on to ongoingly. Ensure that students know what they are to be collecting.

For your information, and to aid your discussions, some ideas are presented here.

The Successful Investigator

"... intelligence, persistence, and resourcefulness combined with experience and common sense. The best private investigators radiate integrity and reliability; they inspire believability. Their confident businesslike, and friendly approach creates the atmosphere of professional skill." (*Buckwalter, 1984, p. 36*)

Interpersonal Skills

Dealing Effectively with People

- Attitude
- Showing interest in others
- Building good human relations

Showing Concern for Others

- Empathy

Establishing Rapport with Strangers

Adapting to Differing Personalities and Circumstances

Communicating Effectively

- Believability
- Clarity and Accuracy
- Asking Good Questions

Persuading People

- Getting a reluctant subject to talk
- Implanting the spirit of willingness
- Coping with the subject's emotions
- Relating to the subject's personal concerns
- Clues into the subject's changing attitude

Ability to Make Friends

Investigation Skills

Analyze	Inspect	Question
Communicate	Interrogate	Reason
Describe	Interview	Record
Detect	Listen	Report
Discern	Measure	Search
Examine	Note	Shadow
Explore	Observe	Sketch
File	Persuade	Use strategies
Find	Perform	Undercover ops
Gather	Plan	Verify
Identify	Photograph	Witness

Personal Qualities

Affable	Discreet	Level-headed	Shrewd
Agreeable	Efficient	Likable	Sincere
Alert	Empathic	Motivated	Steadfast
Amiable	Enthusiastic	Objective	Straightforward
Articulate	Far sighted	Observant	Tenacious
Aware	Frank	Patient	Thorough
Broad-minded	Gentle	Perceptive	Tolerant
Calm	Good-natured	Persevering	Trustworthy
Common sense	Honest	Persistent	Truthful
Considerate	Humble	Pleasant	Unassuming
Courageous	Impartial	Prudent	Understanding
Courteous	Ingenious	Reasoning	Unpretentious
Creative	Interested	Remembers well	Versatile
Dependable	Inventive	Resourceful	Vigilant
Discerning	Law-abiding	Sagacious	

Six I's of Investigation

- Information • the lifeblood of investigation
- Interviewing • the primary "how" of obtaining information
- Interrogation • to examine and probe through questioning
- Intercommunication • sharing, discussing and analyzing information
- Inspection • to take a close and critical examination of information
- Intelligence • something you never have enough of

"Any private investigator involved in examining the scene of an accident, crime, or injury becomes a measurer of distances, size, length, width, and relationships that are necessary to disclose on his sketch of the scene." (Buckwalter, 1984, p. 6)

"Observation is more than seeing; it is knowing what you see and comprehending its significance." (Buckwalter, 1984, p. 141)

Four R's of Investigation

- Rapport • with fellow human beings
- Research • gathering and evaluating important background information
- Records • the investigator notebook: his/her most important investigative tool.
 - carefully records all his/her investigative activity
 - clearly and concisely written
 - covers the investigation in complete detail.Notes are the raw material out of which investigative reports are made. They are also the basis for investigator's testimony in a court of law. The private investigator's records from handwritten notes, sketches, photographs, slides, videos, or diagrams are the best recall aids. Without accurate and complete records the private investigators are "sunk."
- Reports • Report writing, like record taking, is a vital part of all investigations. Actually, reports are the only tangible product private investigators have to sell.
 - what the investigators did
 - what they learned from what they did; and
 - what, if any, evidential information they were able to obtain.The best investigations in the world could be ruined by poor reports. Private investigators should master the basic principles of writing factually and accurately, as top-quality investigations deserve top-quality reports.

For further elaboration on any of these charts, see Buckwalter (1984), and:

Appendix A: The Security Industry

Appendix C: LitFile

Appendix G: References and More Resources – particularly *Baker* (1980), *Buckwalter* (1984) and *Millmaki* (1976)

Lesson 1-1: Seeing with Hands

Duration

45 minutes to 1 hour

Materials

In the kit:

- *Detective Agency* **Kodak Photo-CD**, provided

You provide:

- At least two sets of 5 or 6 different geometrical solids (prisms, pyramids, spheres, ellipsoids, cylinders, cones); 2 identical editions of each, or two sets of matching everyday objects such as dice, erasers (new), cans, small containers, balls, etc.
- 5 or 6 cloth bags

Preparation

- Acquire a "detective" disguise to wear for the first part of this lesson. It could be a crumpled trench coat or cape and a sleuth-looking hat.
- Place one of each of the different solids in each bag. For each solid in a bag there should be an identical solid not in a bag. These other solids can be arranged in any order on a table or chalkboard ledge for easy viewing by the class.

Storyline Problem

How do I get good at seeing with my hands? What would it take to become a good detective?

Instructional Plan

Understanding

Often students look at information such as the shape and attributes of various geometric solids and assume that they understand and will remember/identify their differences. Faced with identifying these solids, for example, while the solids are disguised by being placed in a bag challenges the students to think about expanding the use of their own faculties for data collection/information gathering.

This lesson begins development of the idea that detecting can be thought of as more than taking notes on what is seen with the naked eye; that, in addition, there are other, more perceptive perhaps, ways to "see" and to gather information. The intention is to initiate thinking about what skills and abilities a detective requires.

Planning

To pique curiosities and to begin students thinking of activities associated with detectives and investigations, find some way to invite them to compare the visual information of the geometric solids with the hidden (in the bags) information. There are many ways this could be accomplished; one is suggested below.

Work with the idea of seeing in the dark, seeing with your hands, seeing in ways not usually associated with the idea of seeing. This may be an opportunity to explore the language of the word, "seeing"; to brainstorm synonyms and words that have similar intent, such as "detecting." End the lesson with an invitation to think of "ways of detecting" and how students might become "detectives."

Doing

Because this is the first scene-setting session, the action plans for this lesson are developed in much more detail than the others. The detail is intended to be *illustrative* rather than prescriptive.



Whole Class Activity:

Part 1: Who Am I? Create a "scene of mystery" and challenge students to think of various descriptions of the searching for clues a detective does, the various ways and places clues may be found. For example, you might want to use the following scenario:

1. Suppose one day you were to put on an old trench coat, preferably one that smells as crumpled as it looks, and were to walk into your classroom peering here and there, muttering as you hovered close to a window. "There don't appear to be any footprints here," you might exclaim. Then you would move to the door knob, carefully examining it, then whisper, "There don't appear to be any finger prints here." Then, looking inquisitively up at the class, you might ask, "Who do you think I am?" As the hands shoot up, you continue examining the door and exclaim, "Yes, this lock has been tampered with!" Then as you pull out a magnifying glass to look at the door latch more closely nearly all of the students are now waving their hands wildly and shouting exuberantly, "I know. I know!" At this point, to heighten the excitement, you look up and utter a complete inanity: "Let me give you a clue; I'm not a dentist." By now children will be standing up, just dying to blurt out what they know. Finally you look at Philina, who rarely volunteers to answer anything in class, and say, "Philina, who do you think I am?" And before you are finished she is shouting, "A *detective!*" All the other hands come down, somewhat disappointed in not having been asked, but still excited all the same. One boy still has his hand up. You think to yourself somewhat apprehensively, "Maybe I haven't been able to set the scene enough. Adam doesn't think I'm a detective." So you say, "Yes Adam?" And he says "I think you're a *spy!*"
2. Begin a discussion about detectives with the intent of drawing out children's experiences with:
 - TV shows
 - mystery stories
 - Police stories
3. Bring the discussion around to Part 2.

Part 2: Do we have what it takes to be good detectives? By now, students will be thinking of actions such as detecting, spying, and solving mysteries. Lead them to categorize and summarize verbally those characteristics a good detective or investigator may find useful.

An illustrative scenario:

T: When do detectives work?

S: At night.

T: Why at night?

S: Because that's when crimes are committed.

T: Sounds reasonable. The detectives have to be good at detecting at night when it's dark, to see when it is hard to see. If it is really really dark, how can a detective see?

S: Use your flashlight.

T: That's an idea.

S1: But if you use a flashlight you'll be a sitting duck!

T: You've got a point there.

S: Maybe you could use your hands, and feel your way.

T: Yes, you could use your hands to "see"! A terrific idea.

Guess what I have in these bags?

[After some guessing, point to the bagged blocks on the table.]

T: In each bag is one of these. You can't see it with your eyes.

S: But we could see it with our hands!

T: Do you think you can see like a detective?

Allow time for each "detective" to give it her/his best shot. Allow him/her to feel the bagged solid and then select one of the solids set out on the table. S/he can then pull the block out of the bag to verify their "vision" allowed them to select a match.

If possible, set up several sets of these bagged/unbagged pairs of geometric solids and allow students to form into small groups and explore them extensively.

You may wish to select some solids that are quite different from each other and two that are quite similar. If detectives make a "misidentification" on the similar objects, this can lead to a *discussion* as to why that was a "hard" case compared to the others. Encourage detectives to use the proper terminology (prism, cylinder, etc.) if these words are already part of their vocabulary.

Important: A critical aspect of scene-setting is encouraging detective talk. As children make their identifications with their hands, trigger comment by mentioning things such as "and how did your hands tell you it was that one?" or "and how did you know that was the one?" etc. Be open to any and all comments. This will allow children to bring their "detecting" strategies and skills to the fore.

Some suggestions:

1. The “identification” part of the lesson could be done again with a different set of geometric solids selected from those suggested above. For each variation you may wish to select different ones that are quite similar, e.g. two cones that are quite similar for one round of identification, and two prisms that are quite similar for another round.
2. If you have many variations of a particular solid, say several different pyramids, you could have only pyramids in the bags. You may wish to allow students to make a selection of objects to put in the bags with the intent that “seeing with the hands” will be very difficult. Then have students discuss what made these so difficult. Generate as much *natural discussion and critique* as possible.
3. Challenge students to make up a “test” for assessing “seeing with the hands.”

Looking Back



Whole Class Activity:

Allow students to express their excitement, questions, and findings. Perhaps some have been able to make generalizations. Encourage their expression. Bring the discussion to an examination of the “art of seeing” that includes more than the visual perception of our eyes.

Some suggestions for discussion:

1. How is seeing with the hands different from seeing with the eyes?
2. Is it fun detecting with the hands?
3. Do you think we can be good detectives?

Congratulate all the students for being able to “see” with their hands and therefore having the promise of becoming top-notch detectives.

Beginning to keep Records. Divide one or two pieces of 8.5” x 11” paper into sixths. Suggest that students enter the title, “Seeing with Hands,” and an illustration of it in one of the rectangles created. Ask them to keep this record in their Student Folders (for now) and add to it each time they acquire a new “seeing skill” (another way of seeing).

Seeing with Memory. Anytime throughout the day when a few minutes are available, you can initiate a memory game/challenge. After each one, detectives can fill another square of their record.

Some Suggestions:

1. Remove some things from the room that have been there for a while. Ask your students to recall the items removed and/or details about them. For example, you could remove several books from the shelf and ask them to recall which ones you removed and what they looked like.
2. Display a set of small objects on a tray for a few seconds and then remove them. Ask detectives to list the items that were on the tray. As their skill improves, ask for more intricate details.
Geometric or other mathematical objects are, of course, appropriate as well as everyday objects.

Anecdote:

"Legendary detective Allan Pinkerton, on his first case, is said to have made the following observations with just one glance:

1. Nearly six feet tall
2. Weighing "fully two hundred pounds"
3. At least sixty-five years of age
4. Standing "very erect"
5. "Commanding" appearance
6. Dark hair "slightly tinged with gray"
7. "Very prominent" features"
8. A "very large" nose
9. An "unusually" large mouth
10. "A pair of the keenest, coldest small gray eyes I have ever seen"
11. Wearing a "large, plain gold ring" on one finger of his left hand

– (Buckwalter, 1984, p. 141-142)

Looking Ahead

1. Initiate discussion of how to transform your classroom into a detective agency. What is needed? What/how can students contribute?
Before next class, or during the next set of Lessons, transform the classroom into a detective agency. Begin using the resources you gathered during your preparation for this Section:
 - a. riddles, treasure maps, mysterious events
 - b. books, articles
 - c. mysterious happenings in the classroom
2. Send home the introductory letter to parents (Appendix B: Parent File)
3. Show the *Detective Agency* Kodak Photo-CD without comment. Or, use the Photo-CD during the next Lesson(s) without comment.
4. Post the Thought of the Day title and several Thoughts. For example:

"Be careful of your thoughts, they may become words at any moment."

"Real private investigators are not the romantic, dashing heroes of fiction, embroiled in shooting matches, fist-fights, and acts of violence.... They quietly, patiently, persistently, and often laboriously track down evidence to find the missing pieces to fit together the jigsaw puzzle of clues, leads, interviews, impressions, documents, objects, and whatever to solve investigation problems." (Buckwalter, 1984, p 9).

"Action and excitement are a part of [a real private investigators'] life, but the greater part is just plain intelligent hard work." (Buckwalter, 1984, p 9).

In keeping with a "hidden" sense of humor, and with what we found in a real-life detective agency, you could institute a tradition that students submit "wise" thoughts for posting.
5. Post and/or distribute for coloring and covers: the *Detective Agency* Poses (provided on Copy Masters INTRO.F, INTRO.G, and INTRO.H):
 - a. A surveillance scene
 - b. A magnifying glass scene
 - c. A wanted poster scene

Detective Agency Decor

In the real-world of investigations, agency decor is rather non-identifiable as anything other than an office. It is the activity that happens there that makes it into a *detecting place*. There are some clues, however, that could be highlighted, and which would help the *Detective Agency* to become "real" and operable in the minds of your students (and for you, the teacher):

- In keeping with the necessary secrecy of the place, bring in two phones and label them, "Hello-Phone" and "Answering Service."
- Post pictures of detectives at work.
- Bring in books and artifacts that suggest mystery and intrigue. Be creative.
- Create an **Agency Note Board** (title provided in kit) where all announcements and incoming call information may be posted.
- Use the letters provided to create a name plate for your agency door.

Students can contribute with

- their own drawings, posters, charts, displays, and favorite books, both fiction and non-fiction.
- spontaneous discussion of possible ways to enrich the place.
- any literature (pamphlets, picture books, novels, records, etc.) that deal with life in a detective agency.
- a "center" created for personal interest as well as research information for your students.
- secret codes.

Charts and graphs may be generated by the detectives. Students will want to display them as a way to represent their Case Work findings, and to enhance their culminating presentation.

Lesson 1-2: Seeing Too Much

Duration

30 to 45 minutes

Materials

You provide:

- Squared paper for graphing
- **Copy Masters:** one copy per student group
 1-2A: *Seeing Too Much*

Preparation

Select a piece of writing for the students to use in searching for and graphing the Vowel Gang. You may use a passage from a mystery or detective novel or use **Copy Master 1-2A**.

Prepare to do something mysterious.

Storyline Problem

Beginning to explore “detecting” as “seeing”: How can we see what we sometimes overlook?

Instructional Plan

Understanding

This lesson enlarges the view that seeing well involves more than cursory inspection or reliance on visual memory. The activity of counting and graphing the **Vowel Gang** is relatively short but highlights the need for precision and accuracy in data-gathering.

Planning

This is essentially a quick lead-in into thinking about the required characteristics of detectives—and the different ways of seeing (or gathering information). Use the **Vowel Gang** example to initiate discussion of detecting and detective agencies. You could present a piece of writing (Exhibit 1-2A) on an overhead, a bulletin board chart, or a copy per student. Ask for and record predictions before the counting.

If students are currently involved in a mystery or detective novel, they may choose a selection from it to use in vowel seeking and graphing. The purpose is to create a sense that what is obvious is not always seen, and what we think we see is not always the same as what others think they see!

Doing

Initiate, or continue discussion of our ability to see in various ways, more than with our eyes. Lead students to explore conceptual as well as physical ways to see. Exploring the verb, “see.” Its synonyms may enlighten the discussion.



Whole-Class Activity:

Illustrative Scenario:

T: Sometimes we see things so much that we don't really see anymore.

S: Like snow in February?

T: Yes, or like the letters of the alphabet displayed above the chalkboard. For example, how many times in your life have you seen the letter "a", or the letter "e" or "l" or ...

S: "o" or "u" or sometimes "y"?

T: Let's call these the "Vowel Gang."

Which member of this gang have you seen most often?

Least often? [Record these predictions on the chalk board.]

How can we check our predictions?



Small Group Activity:

In order to verify their predictions, children could examine the exhibit, count the number of times each vowel occurs, perhaps using tallies, and graph the results. Groups of five would work nicely – one person making a tally for a vowel.

Strive to develop a sense that accuracy and precision are important in detective work.

Looking Back

Whole Class Activity

Share their graphs and findings. Allow differences to generate discussion and critique.

Some Suggestions:

1. Compare differences in the graphs from one group to another. Why the differences? Why do we get different results? Can detectives rely on mistaken data? Would good detectives overlook these differences? Why not?
2. Compare results with the initial predictions. Why such differences? Why are our initial impressions often so inaccurate? Can we rely on initial impressions? Are initial impressions sometimes accurate? Can a detective rely only on initial perceptions or impressions?



Looking Ahead

Show the *Detective Agency Photo-CD* at appropriate times. Use it without comment to provoke ideas and questions about choices and possibilities for your own agency.

Spend as much time as appropriate establishing the *Detective Agency* in your classroom. This will be an ongoing activity and should be guided by student interest and enthusiasm. It is important, however, that the sense of their being detectives in their own agency be established early and maintained.

Ensure that the guidelines are all flexible, for as the *Detective Agency* work progresses, the expectations and requirements may evolve as well.

Identity Question

How can we describe ourselves without giving away what we do and yet identifying ourselves as someone who is a detective or private investigator?

- Think of codes? *I.p.* instead of *p.i.*?
- Think of names: *Grade Five & Associates*, *Mary John and Associates*? What does "associates" mean? Could we spell private detectives backwards: *sevitceted etavtrp*?

Suggestions for Atmosphere:

1. Name for the agency.
Children have suggested names such as:
"The Cool Detective Agency"
"The No-Name Detective Agency"
"Dragon Detectives"
2. Mascot for the agency.
3. Logo for the agency.
3. Agency telephones and fax numbers.
4. Personalized detective ID cards. (These are provided in Lesson 1-5).
5. Personalized detective badges.
6. Trench coats, hats, gloves, etc.

Suggestions for Establishing Qualities of Good Detectives:

1. Astute in observation.
2. Looks for alternatives.
3. Critical in accepting evidence.
4. Precise in thinking and careful in making a case.
5. Aware that cases can be "thrown out of court" for sloppy detecting and rash judgment.
6. Discusses case work with other detectives as well as the Chief Detective.

Suggestions for Agency Setup:

1. Large group (whole class) briefing area.
2. Small group conference area.
3. Storage place for solved detective cases.
4. Easy access to the manipulatives for the module.
5. Place for "extra" cases to solve (enrichment).

Suggestions for Agency Policy:

1. Policy decision should be jointly formed by both detectives and the Chief Detective.
2. As a joint policy, all detectives (including the Chief Detective) can be reprimanded for violations of policy.
3. The policy should be posted in a conspicuous place.
4. If a detective is outside the agency investigating a case, s/he must carry his/her license.
5. Detectives often work in teams but on occasion also work solo. We have found that when detectives work in pairs, rich problem-solving conversations occur.
6. Detectives work in certain agreed-upon locations.
7. Case reports must contain a record of time devoted to a case and be signed by the Chief Detective before filing. This allows the teacher to monitor case work as well as to provide important "professional" training.

Seeing with Memory. Continue to provide opportunities to play with increasing memory skills.

Some suggestions:

Bring in a single flower per group and allow students to study it for a short time. Remove it and ask them to recall/record its details. Return the flower to them and ask that they compare the "actual" with their recollections of it. Discussion of the comparison and ways to improve seeing with memory could enrich the experience.

Lesson 1-3: Seeing Through Shape

Duration

30 to 45 minutes

Materials

In the kit:

- Polygon Cutouts (preparation required)

You provide:

- **Copy Masters:** one copy per student
1-3A: Seeing Square Numbers (4 pages)

Preparation

- Use a paper cutter to cut apart the polygon cutouts into strips. Each group will need at least 16 squares, 16 equilateral triangles, and 16 trapezoids. **Save them for later use as well.**
- Prepare the **Copy Masters** as set or Exhibit, by mounting or stapling them.
- Prepare to do something mysterious to introduce the Lesson. For some suggestions, see the *Preparation* suggestions in the *Section Summary* for this Section.

Storyline Problem

How can a detective see through appearances/disguises?

Instructional Plan

Understanding

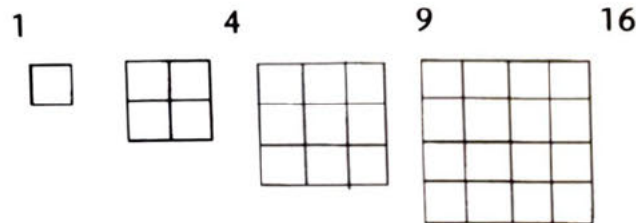
By exploring 3 sequences of square(d) numbers, detectives are challenged to discover the “real” meaning of the term, “square numbers.” Square, triangles, and trapezoids are used to illustrate “squaring” and detectives are expected to see patterns though they are asked only for “solutions.”

The question about which representation is a disguise and which is the “real” shape of square number is meant to make students ponder the point that the naming of square numbers was a happenstance in the history of mathematics. It could have been otherwise. The fact of the matter is that we have become accustomed to using squares to measure area, but we could just as well use triangles. “Square” measure can be done with triangles, trapezoids, hexagons, or parallelograms, too. “Square” has as much to do with two dimensions as it does with the shape of a square (which of course is two dimensional). Squares are just one of many two dimensional shapes. However, squares have become the *standard* form for square numbers. So now we don’t bother to think about it. This case illustrates the inherent *flexibility* in mathematics. There are many ways of doing things mathematically. There may be *standard* ways, and these are important, but there are always alternatives to the standard, and in considering these, the student acquires real insight into the nature of mathematics.

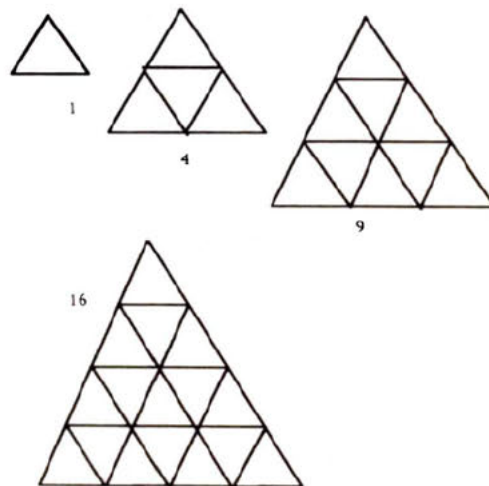
Planning

This challenge is another introduction into the work of detectives. Encourage students to think of it as an exhibit that may have been posted at the office, or that they encountered in a "detectives fair." Setting out a plan, considering the evidence, and coming up with some answers is part of the work. Encourage discussion of each part of the process; talk to each other as detectives solving a challenge. Outlined below are possible solutions to the challenge.

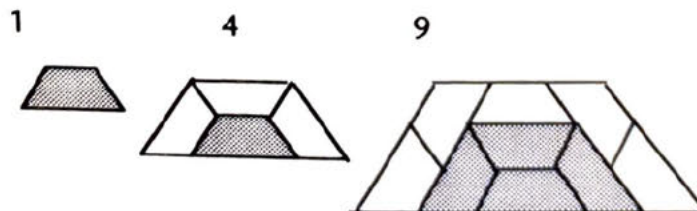
Exhibition 1-3a: Here are the first four square-looking square numbers:



Exhibition 1-3b: The first four triangle-looking square numbers:



Exhibition 1-3c: The first three trapezoidal-looking square numbers:



Notice how the next larger "square" can be made from the previous one by wrapping it with an over-arching layer of trapezoids. The shading tries to indicate the wrapping process. You might wish to use this wrapping process to help students with this activity. Try it out on the next larger "square."

Doing

Renew the discussion of seeing in various ways, and suggest that information may be disguised (intentionally or otherwise) and be more difficult to see. What skills would a detective need to see through disguises? Do adults sometimes see things differently than children? Why?



Small Group Activity

Present the *Exhibits: Copy Master 1-3A: Seeing Square Numbers* (4 pages), and the challenge which is presented on the first page of the Exhibit. Suggest that some tools may be helpful (the polygons made from the Polygon Cutouts) and making drawings may be useful. Detectives keep careful records as evidence!

Expect they will use squares, triangles and trapezoids, but other shapes may also be used.

As they work, encourage them to look for patterns—in the numbers and in the shapes.

Looking Back

Whole Class Activity:

Detectives should bring the solutions/conclusions back to the whole group. Encourage them to demonstrate with the manipulatives they used, and to discuss the drawings they made in their notebooks.



Looking Ahead

Anticipate using new-found seeing skills, seeing in ways beyond physical demonstration (through disguises, for example).

Think about *Tools for Detecting*, and expand the notion that tools are simply physical constructions, and may include:

- hands, eyes, ears, and other senses, including a “sixth sense” or hunches
- paper, file folders, notepads
- telephones, computers, dictaphones
- cameras, audio- and video-recorders
- cars, vans, and human legs
- magnifying lens, microscopes, etc.

Bring out the fact that there are innumerable ways, means, and therefore, tools, at their disposal, and a good detective will access a wide variety of these. S/he should always be looking for another way to see!

Other tools may be created as suggested or as they are seen to be required by the students. For example:

- An accounting system/book may be established
- A system of clocking in and out with an accompanying pay-out/wage system may be used
- Equipment may be ordered from office furniture catalogues and their prices calculated and compared

Seeing with Memory.

Some suggestions:

A number of detective books give summaries of face shapes, fingerprint patterns and so on. These could be adapted to "seeing with memory" (observation) skills. For example:

- Head shapes: flat back, bulging back, round, pointed, egg-shaped, flat top (Compare with the solids in Lesson 1-1!)
- Ear shapes using geometric terms
- Face shapes (long, oval, round, wide) and ears, foreheads, eyebrows, eyes, noses, mouths, beards
- Voices
- Clothes and body shapes
- Fingerprint patterns: loops, arches, whorls, ridges, bifurcations, trifurcations, spurs or hooks, bridges, dots or islands, enclosures, right-sloped, left-sloped
- Shoe print patterns: ridges, depressions, worn ridge ends, broken ridges
- tire tread marks/patterns
- handwriting analysis
- computer fonts
- designs on money (counterfeits?)—use magnifying glasses, microscopes
- Hair: lines, style, color, texture, and hair composition (see alternate Lesson Idea 2-6: Using a Video Camera)
- Animal tracks
- Landscape marks

Your detectives could make their own Identi-kit (like Mr. Potato Head).

Detectives could disguise themselves in such a way as to be unrecognizable to their colleagues. Is this possible?

For further ideas, see **Appendix G: References and More Resources** particularly *Baker (1980)*, *Buckwalter (1984)*, and *Millmaki (1976)*.

Lesson 1-4: Seeing with Chairs

Duration

30 to 45 minutes

Materials

In the kit:

- Polygon Cutouts, prepared for Lesson 1-3

You provide:

- scissors
- chart paper and pens
- **Copy Masters:** one copy enlarged, or one copy per group

1-4a: Seeing With Chairs

Preparation

Make the Copy Master into an **Exhibit**. Enlarge it into a poster or make one copy per group. For the group, you could attach it to heavier cardboard so it will stand up as a display.

Obtain catalogues that show furniture, such as tables of all shapes, if possible.

Storyline Problem

How can seeing in different ways help us solve a client's problem?

Instructional Plan

Understanding

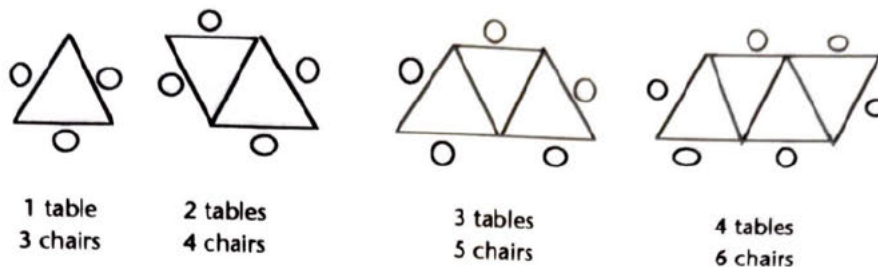
Detectives are asked to solve a practical problem of seating arrangements for coffee-ing. As they explore seating arrangements they will begin to see patterns emerge that enlarge or restrain the seating capacity around the tables (perimeter).

Set out the materials and the problem and challenge your students to explore possibilities and reach some general conclusions. They are to estimate. They may use the polygon cutouts; no formulas are required. Encourage generalizations that express perimeter in relation to chair space (chairs placed around the perimeter).

Planning

Present the "Seeing with Chairs" case as an Exhibit, an example of a case to be solved—for practice in seeing. Challenge detectives to see new (and multiple) ways to solve the problem—and to explore the patterns that happen as they explore.

For example:



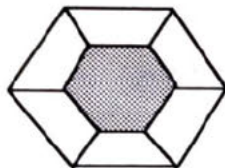
This growth pattern suggests that with each additional triangular table only one more seating place is attained. Not a very efficient use of tables.

The trapezoid arrangement increases as follows:

1 table	2 tables	3 tables	4 tables
4 chairs	6 chairs	8 chairs	10 chairs

...which leads one to anticipate that with 6 tables one would get space for 14 chairs.

But notice what happens if the arrangement closes back upon itself:



We get seating for only 12 rather than 14. But of course this seating might be quite a bit more "cozy" than a strung-out arrangement which would seat 14. Perhaps this hexagonal arrangement would be ideal for a chess master who was playing six novices simultaneously. Or it could be a work station for a busy detective!

Doing

As detectives explore the problem, encourage discussion, use of manipulatives (the polygon cutouts), and recording of some arrangements that "work" and why. Use the terminology: seating capacity, and look for qualitative arrangements as well as patterns of arrangement.

Explore possibilities. Then explore alternate arrangements in all combinations:

- How can these tables be put together?
- What difference does it make?
- Which shape is most versatile?

Other arrangements to look for:

- the least usable table space
- the least seating space
- the most interesting space
- enough aisle space (without waste), and so on.
- Which shape offers the most usable work space? Do the people using the chairs need to reach into the center?
- Are some shapes more "cozy" than others?

Note: Students picture/estimate how many chairs could be seated on each edge and thereby estimate perimeter.

Looking Back

Whole Class Activity:

Call an *Assembly* and allow each group a few minutes to summarize the relationships and patterns they discovered. Encourage demonstrations using manipulatives and drawings

Extension Activity:

Draw classroom furniture to size, according to the size of tables that are actually in your classroom. For example, students could design custom-tailored desk tops.



Looking Ahead

What detective skills are students learning?

Begin a wall chart of detective skills and add to it on an ongoing basis. This will become useful in generating categories and qualities lists for the résumé.

What are students learning about detective agencies?

- Have you ever been in one?
- How valid are ones on tv?
- How can we find out?

Lesson 1-5: Seeing Through Arms and Legs

Duration

1 hour

Materials

In the kit:

- **Poster:** Agency License, to post
- **Résumé Folders**, one per student
- **Agent Licenses** (and plastic covers), one per student

You provide:

- measuring tools
- "ink" for fingerprinting
- **Copy Masters:** one copy enlarged, or one copy per group

1-5a: *Seeing Through Arms and Legs*

Preparation

- Make the Copy Master into an Exhibit. Enlarge it into a poster or make one copy per group. For the group, you could attach it to heavier cardboard so it will stand up as a display.
- Peruse the Résumé Folders to prepare the necessary measurement tools.
- Plan how to make the fingerprints. What "ink" will you use?

Storyline Problem

How can we see ourselves and others with accuracy?

How can we see through appearances/illusions?

Instructional Plan

Understanding

This is a simple challenge which invites detectives to use keen observation skills. Hands and arms, when outstretched, provide an elongating effect that is quite powerful. Mathematically, the "body segment" is a representation of a line segment. Of course the arms and legs are also line segments. Generally "stick people" are just a set of line segments stuck together. You may wish to emphasize the term "line segments" when talking with your detectives.

Planning

In this Lesson, students solve a detecting challenge and learn more about their own seeing ability. Incidentally, but importantly, the Agency and the agents become "licensed." You could plan a ceremony or some other celebratory event for this.

Doing

Set out the materials and the problem and challenge the students to explore possibilities and reach some general conclusions. They are to estimate and then measure.

The case is one of trying to identify stick men in a *Mugline* incup. When they wave their arms and legs they appear different (longer). Are they?

Looking Back

Whole Class Activity

Look back at "seeing." Discuss the "art of seeing" in relation to body shape and movement. Where any generalizations drawn from the *Exhibit/Challenge*?



Looking Ahead

1. Hang the Agency License (Poster: Agency License)
2. Distribute Agency Licenses and their plastic covers. Discuss their content and how detectives could design their own number from information they have about themselves. For example, after the PA O... could be a number such as 2683.09.16 JJ, a compilations of the number of agents, the year, month, and date of birth, and initials of the agent to whom this license belongs. Each student should have a unique number that will be used as identification throughout the *Detective Agency*.

Alberta
Solicitor General

PA O _____ - ____ - ____ - ____

Private Investigator Agency

Name: _____

Agency: _____

Date of Issue (mm/dd/yy) _____

This card must be produced for inspection upon request. It does not give the holder the authority of a peace officer.

Talk about the requirements of the agents (detectives) and bring out that detective agencies (in Canada, private investigators) must be licensed by the government. Discussion about this requirement could lead to speculation about the nature of detective work.

- Is the work dangerous? [In Canada, private investigators are not allowed to carry a weapon/gun, but may apply for permission to do so under special circumstances and for a limited time.]

- How is it different from other occupations that require licensing, such as teaching or welding?
- Who is the Solicitor General?
- Why would a lawyer be associated with this kind of license.
- Why would agents be required to belong to an agency?
- Why would an Agency be a special place to work?
- Could one person be an agency?
- Why would someone want to work alone?

If there are some questions that remain unanswered, suggest students begin an investigation into what detective agencies (or private investigation agencies) are about. What resources are available in the library? How could information that is not available in your school library be located?

3. Distribute the **Résumé Folders** and ask detectives to complete the information asked for. Note that they will be required to measure and fingerprint themselves.

Continue the discussion of detective characteristics and the need to compile data/information about their developing skills. Add to the wall chart of detecting skills, and as they are ready, encourage detectives to group them into categories that may be suitable for their résumés. This is an ongoing activity in preparation for the culminating events.

Some Possible Résumé Categories

personal information

attitudes

attributes

capabilities

education/training

investigative experience

- previous/current
- school
- home
- other
- cases solved

skills:

- interpersonal skills
- observation skills
- analytic skills
- measuring skills
- reporting skills

strategies

Some Suggestions:

Consider these questions:

- What will they be looking for in themselves?
[skills, knowledge, training, attitude, capabilities, attributes, strategies, for example]
- How can these be recorded? How can we keep track?
- Will they be helping each other notice the development of these?

Offer the students a job in your Agency (classroom). Ask them what they would have to do to apply for such a job. [submit a résumé, and get a license]

Appendix A: The Security Industry can be used to brainstorm the list.

Note: This work may be compiled on a computer if one is available.

Further suggestions may be found in:

"Finger Prints" (1991) in the **Ideas** section of the *Arithmetic Teacher* 38 (7) 24-33.
Presents ways of classifying and identifying finger prints, some of it in a detective motif.

Barnett, C.S. (1991), "Sneaker data sheet," *Arithmetic Teacher* 38 (5) 26-33.
Can use "footprints" as well as fingerprints to make identifications.

Math Purpose

Lesson 2-1: Calculating Mileage

To review kilometers as a unit of length and calculating area, a distance measurement.

To construct a form for calculating area and organizing data.

Lesson 2-2: Substrate at the Law Office Part

To practice reading the numbers and using them.

To solve problems by working on a coordinate grid and using a compass.

Lesson 2-3: Check the Cashiers

To compute with money in a real problem-solving situation.

Optional Cases

2-4: Topping Drives the Spray

To practice measuring with a ruler and using a compass.

2-5: Mixed Up Boxes

To practice measuring and calculating area and perimeter.

2-6: Using a Video Camera

To use a video camera to record a performance and to use a video camera to record a performance.

Section 2:

Detectives for Hire

Section Summary

Duration

2-3 hours

Storyline

Detectives begin work on "mini-cases" and in the process develop their own reporting forms and procedures. During work on the first case, detectives explore the need for a reporting form and how they could manage the process. Using the second case as example, they develop a form, and then test it on the third case. Optional case suggestions are given as well.

Math Purpose

Lesson 2-1: Calculating Mileage

To review kilometers as a unit of length and organizing simple financial transactions.

To construct a form for collecting and organizing data.

Lesson 2-2: Sabotage at the Ice Cream Plant

To practise reading temperatures in degrees Celsius.

To solve problems by working backwards (retracing steps in an event).

Lesson 2-3: Check the Cashiers

To compute with money in a real problem-solving situation.

Optional Cases

2-4: Topping Down the Slurpy

To practice measuring with mL and L in a problem situation.

2-5: Mixed Up Boxes

To solve problems involving mass measured in grams.

2-6: Using a Video Camera

To use electronic technology to get a magnified view of small objects (less than a mm) that are difficult to distinguish using the naked eye (mm).

Math Objectives (Alberta Education)

In this Section, students use dates and times to organize information, distinguish between information which is extraneous to a description and that which is central, select objects that have a mass of less than a gram and objects with a mass greater than a gram, use the ideas of precision and accuracy in an intuitive way to develop a problem solving strategy in a game situation.

Specifically,

M27 estimates and measures mass (grams)

M29 uses appropriate standard measuring units for mass: gram

M35 reads the Celsius thermometer, and uses the symbol °C

M36 determines the reasonableness of Celsius thermometer readings in a situation.

P13 knows what information is extraneous

P24 works problem backwards

Materials

In the kit:

- *Detective Agency* Kodak Photo-CD

You provide:

- rulers
- calculators (optional)
- labeled containers (optional)
- graduated cylinders (optional)
- scales to measure about one gram (optional)

Preparation

Familiarize yourself with the contents of the Module package. These lessons are part of the organization of the cases that will be the major activity in **Section 3**. Discussion of the procedures in a detective agency may bring questions about the upcoming work that you may want to answer/organize now.

Connections

Assessing and Monitoring

Periodically enter remarks about student interest and mathematical behavior in the Events-based Recordkeeping Charts (Copy Master Intro, F: Events-based Recordkeeping Chart) especially at the end of the section.

Assessment in Context

Conferencing: Use an initial conference with each detective to assess understanding and involvement in the *Detective Agency*, and as an opportunity to talk about the purpose of conferences. Emphasize that the intent of Detective Conferences is to see if we can improve our detective strategies and skills.

Recordkeeping: Update both **Objectives-Based** and **Events-Based Recordkeeping Charts**

Student Self-Assessment

A "Detective Qualification Examination"

Discuss their responses and how their answers may now be different.

Some questions could be:

Description of Investigation:

1. Three ways in which detectives can see.
2. Three rules for the *Detective Agency*.

Significant Discoveries:

The four steps of solving a problem are:

Questions and Concerns:

1. What are three questions you might ask about a case?
2. Why do you feel you might be a good detective? (summary question)

Files

- **ComputerFile**
- **LitFile**
- **PSFile**

Ongoing Events

- **Seeing with Memory:** You may have found another aspect of seeing that could be added to these impromptu explorations.
- **Student Folders.**
- **AskMe Logbook.**
- **Culminating Presentation.** Students begin here to compile data for their Résumés.

Integration Opportunities

STS Issues

- **Data Abuse.** What is it? With the advent of computers and high-tech tools, information has become a commodity that can be bought and sold, and therefore stolen and/or protected. Does this matter? Should people be allowed to "listen in" on conversations, via cellular phones or electronic mail, for example. What technology should be allowed? (Zonderman, 1990). What information about us is collected in databases? Does it matter? Should we be required to give our social insurance number? What use is made of private information from census-taking and social insurance files? What numbers should we give out? Credit cards? Financial information? Which companies sell their databases to advertisers? Should that be allowed?
"Increased information and technology could create a safer society, and ... that information and technology could be used to create a less free society" (Zonderman, 1990, p. xvi)
- **The Media.** How does media affect our understanding of what goes on in the world? Are we able to identify "fact" and "fiction"? Does it matter?
"Real private investigators are not the romantic, dashing heroes of fiction, embroiled in shooting matches, fist-fights, and acts of violence, sex, and intrigue. They quietly, patiently, persistently, and often laboriously track down

evidence to find the missing pieces to fit together the jigsaw puzzle of clues, leads, interviews, impressions, documents, objects, and whatever to solve investigation problems... Action and excitement are a part of their life, but the greater part is just plain intelligent hard work." (Buckwalter, 1984, p. 9). "Forensic scientists, as well as television producers, are not above performing outlandish experiments in their efforts to determine identity" (Zonderman, 1990, p. 37).

Science

- Forensic medicine

Social Studies

- Mapping

Art

- **Illustration.** Recreate the scene of a crime in a graphic way.

Language Learning

- **Report Writing.** Explore the differences between report writing and fiction.

Health

- **Fitness.** Examine fitness of detectives through heart rate, speed of recovery. Examine readouts from monitoring devices such as ECGs

Physical Education. Experience and discuss movement through large spaces, and an awareness of body movement and space. Balance, precision, and large motor movements.

Computing

- **Recordkeeping.** Keep the records of the agency on computer.

Mathematics in This Section

This Section focuses upon setting up the "paper work" of the agency: How to report cases and how to keep track of progress in becoming detectives. In order to have students participate in setting up this paper work, examples used in this section for reporting case work provide an opportunity to do some *measurement* involving *grams*, *°C*, *mL*, *L*, *km* as well as to plan how to *present data* and information about their growing capabilities. The use of the Macro setting on a video camera (optional activity) allows small units of *length measurement* (mm) to be seen in greater detail so that a mm doesn't appear so tiny.

About Report Writing

"Reports disclose what the investigators did and what they learned from what they did; and what, if any, evidential information they were able to obtain. The best investigations in the world could be ruined by poor reports" (*Buckwalter, 1984, p. 60*).

"Ability to prepare a clear, factual, accurate, and impartial report is one of the investigator's most important professional tools" (*Liebers & Vollmer, 1954, p. 16*)

"A sloppy or incoherent investigation report will indicate that the investigation was conducted in a shoddy or haphazard manner" (*Golec, 1976, p. 33*)

The investigative report "should be written with such clarity and accuracy that the one for whom it is intended will understand all the facts presented" (*Buckwalter, 1984, p. 206*)

"Prior preparation is essential to good report writing. Notes should be analyzed, selected, and arranged according to the chronological order of investigative events and the importance of information" (*Buckwalter, 1984*).

Writing the Report

Steps in Report Writing

1. Planning
2. Reviewing and arranging notes
3. Gathering all the evidence
4. Organizing material in logical order
5. Setting out a format
6. Outlining the Report
 - Order of presentation
 - Major information items including conclusions or recommendations
 - Supporting materials
7. Arranging notes and other information according to outline

Qualities of a Good Report

1. Accurate
2. Brief
3. Complete
4. Factual
5. Specific
6. Logical

Format

1. Identifying information:
 - Case identification, or file number
 - Name or description of assignment
 - Date and time period covered
 - Identification of investigator
2. Major activities of the investigation including notes
3. What was found, conclusions, answers
4. What remains to be done, or could be done, or should be done

Lesson 2-1: Calculating Mileage

Duration

45 minutes to 1 hour

Materials

You provide:

- rulers
- calculators (optional)
- **Copy Masters:** one per student
 - 2-1: Calculating Mileage**
 - 2-1A: Route Map**

Storyline Problem

Now that we have a Detective Agency, how will we get clients/cases, and what will we do then?

Instructional Plan

Understanding

Detectives are given a mini-case to solve — a task not unlike what they may be expected to do as detectives: calculate their mileage. In solving it, they are asked to pay attention to (see) what is needed for the solving of cases in their detective agency, and how their work is reported. The mathematics in the case is a review of previously learned material, and therefore is not the major focus of the Lesson.

Planning

This Lesson takes a critical look at the organization and operation of a detective agency. It is likely that you have established a name, discovered phone numbers, and drawn logos. If you have not done so, this may be an appropriate time to hang the letters of your name on the door, if that is the plan. The **Agency License** should be posted, and the students should have received their **Agent Licenses**. They have “come to work”! How can they go about doing that work and how do they record and report it?

Information

Often investigators do not meet clients in the office.

In Canada, they normally cannot carry a weapon, but can request permission from the Solicitor General to do so for a specified length of time.

- Clients are often law firms or insurance firms.
- Most of work: making observations
- Skills: in observing but not being observed, patience, being inconspicuous
- Forms are very important because of the legal status of the information. The form is set up so they do get the required information – and the forms can vary from one state/province to another.

Doing

Initiate a discussion by posing the Storyline Problem 1. You may want to show the *Detective Agency* Photo-CD once more with these questions in mind.

Some suggested questions:

- What happens in a detective agency?
- How are they organized?
- What kind of work do they do?
- How do they get their cases?
- What happens when someone phones in a request?

Brainstorm what needs to be recorded and how. What kinds of things need to be reported? Why?

- Where are records kept?
- What is in the files?

Bring the situation into your own classroom.

Distribute the Copy Masters and ask that the detectives be aware of what is needed to solve and record the solutions.

- what tools are needed?
- what information needs to be recorded?
- where could the notes be kept? Is there more than one kind of data?

Looking Back

Whole Class Activity

Discuss the solutions to the mini-case and talk about the process (materials, information, and organization needed) used in solving and reporting it. Record the suggestions as a web on the chalkboard, or in chart form.



Looking Ahead

Focus on the need for a reporting procedure – for that is what the Chief Detective (and the client) needs for the case to be completed. What should it look like? What needs to be on it?



Lesson 2-2: Sabotage at the Ice Cream Plant

Duration

1 hour

Materials

You provide:

- **Copy Masters:** one copy per student or group
 - 2C:** *Case Report Form*
 - 2-2:** *Sabotage at the Ice Cream Plant*
 - 2-2A:** *Melting Ice Cream*
 - 2-2B:** *Layout of the Ice Cream Vats*

Storyline Problem

How can we report the cases we solve?

Instructional Plan

Understanding

During this Lesson, students begin to formalize their detecting procedures. The process of “Working on Cases” is systematized. Detectives: receive a request; accept the case; follow through or research/solve the case; and then write a formal report. The report is “tested” by an example. As in the previous Lesson, the mathematical content in this case is a review of earlier concepts (temperature, °C).

Planning

Work with the students to brainstorm/discover a method of doing **Case Reports**. In Section 3, cases will be offered as **Case Sets** (packages) and detectives will be expected to work through them and make a final reports on each case. There are pads of note paper provided as well, and students should be encouraged/required (as private investigators are) to keep their primary data (their ongoing notes). Often investigators are required to submit these notes as evidence should the case go to trial. This Lesson sets up the recording/reporting process.

Doing

Small Group Activity

Provide a Case Report Form (**Copy Master 2C**) for each group and ask them to discuss its apparent usefulness.

Distribute the **Copy Masters** for the *Sabotage at the Ice Cream Plant* mini-case. Ask detectives to work out a way to evaluate the report form as they solve the mini-case. Filling it in would be one way.





Looking Back

Whole Class Activity

Ask detectives to talk about the **Case Report Form**. If for some reason, students feel the form should be modified, this is the time to bring that discussion forward.

- In making a report, the words chosen should be descriptive as well as concise. This is a report, and the language of making a report is different from that in a novel.
- The joint signatures indicate cooperative effort/awareness, mutual responsibility and respect.
- The recording of details such as "time in", "time out", and "time on" reflects the significance of the chronological dimension in detective work.
- Note that primary data such as scraps of paper with license plate numbers written in a hurry are important in building evidence for a case should it be required to go to court and will need to be attached.

Reach a consensus on a form that would seem to work. Chart the categories/titles and post them to use in the next Lesson. It can be modified then as well.

Looking Ahead

Pose the question: Can all cases be handled in the same way?

Reminder: The abilities/skills/strategies demonstrated in this Lesson are good résumé data.

Lesson 2-3: Check the Cashiers

Duration

30 to 45 minutes

Material

You provide:

- calculators (optional)
- **Copy Masters:** one copy per student
 - 2-3: *Check the Cashiers*
 - 2-3A: *Cashier Transactions*, 2 pages

Storyline Problem

Can one reporting form be used for all cases?

Instructional Plan

Understanding

Again, detectives solve a mini-case. This time they use the reporting form they used. It may be only a chart at this point, but part of the skill of being a detective is improvising and reporting clearly. Detectives should be able to make a report from the list. The mathematical content (computing with money) is a review of procedures learned earlier.

Planning

Encourage discussion of the process of solving a case. A chart of the process may be made if it is useful. In the doing of these mini-cases, the classroom becomes an operating *Detective Agency* so modify the process until it works smoothly – with the setting up Section 3 in mind.

Doing

Small Group Activity

Distribute the **Mini-case** and its **Evidence Sheets**. Ask the detectives to prepare a Case Report.



Looking Back

Modify the Case Report chart as necessary. Ask: Can this form be used for all cases.

Talk about the mini-case and how it was solved. Are there any generalizations about cases that could be made? How much information is necessary? What resources need to be accessed in solving cases? [remember the personal skills as well as tools, and other, outside resources] Is it all right for detectives to seek help outside their agency? Where?

Looking Ahead

A lengthy, reflective entry in the **AskMe Logbooks** may be appropriate here.

A suggestion for topic:

Becoming licensed detectives and using a variety of tools.

Ask students to project ways in which they can solve cases with the tools (physical, visual, and conceptual) that are available to them.

Suggest they start writing cases and recording them in their **Problem Books**.

In the next section, detectives will begin solving cases on their own. Ask them to think about how the Cases themselves could be managed. Ask,

- How do detectives get Cases?
- What do they do when someone phones?
- How would you go about solving and reporting a Case?
- How would you organize your work?

Some suggestions for continued activity:

Lesson 2-4: Topping Down the Slurpy *optional*

Mini-case 2-4: see Copy Masters

Lesson 2-5: Mixed up Boxes *optional*

Mini-case 2-5: see Copy Masters

Lesson 2-6: Using a Video Camera *optional*

Storyline Problem:

How can we see in different ways with a video camera?

Understanding

Video cameras are widely used in surveillance work. While most shots are taken from a distance, use of a video camera for taking close ups is also important. The "macro" setting on the camera enables detectives to take some close up shots that can also help in making precise measurement.

Planning

Detectives will become involved in recording some "micro" events using the macro setting on the video camera. Then by examining the images, they will make precise statements about their recordings that would not be possible without the use of the Macro setting.

Detectives will first make recordings of an event using the ordinary setting and then make recordings using the Macro setting. By making comparisons between the two sets of images, they will arrive at some conclusions about the usefulness of in-close observations for gathering precise evidence.

Doing

Whole Group Activity

Open with a discussion of seeing with a video camera. How can that be different than seeing in other ways?

Present the following detective scenario:

We are at the scene of a crime making a video record of all important evidence. Some strands of hair are found in the victims finger nails. How can we capture the hair with the video camera?



Have students try taking shots with the camera. If they do not use the macro setting the pictures will be completely inadequate for making a record.

Point out the Macro setting and ask if anyone has ever used it or seen someone else use it? Experiment with the macro setting and watch the image on the monitor.



Small Group Activity

If enough cameras are available, break into groups to solve the following problem/case:

Who in the classroom (or squad) has the thickest hair? The thinnest?

If there is only one camera, students can take turns trying to use the macro setting to get a clear image.

Looking Back



Whole Class Activity

Call an Assembly in which you hear a short statement from each group about their hair thickness findings and how the video camera helped them see in different ways

Section 3:

Conducting Investigations

Section Summary

Duration

18 – 20 hours

Storyline

Detectives in this section take on-the-job the solving of Cases. This Section is relatively free flowing work experience as detectives in the *Detective Agency*. Detectives are involved in solving a series of Cases and in reporting their findings in a formal report. As well, they meet regularly in Conferences and for Assemblies.

Math Purpose

Case Set 3-1: Wanted: Hexy

To construct the hexahedron from nets and from straws, to describe and name the solid, and to recognize it in the natural environment.

Case Set 3-2: Capturing BlockHeads

To construct, describe and name 3-D objects (prisms, pyramids, cones, cylinders) that can be made from nets and to recognize such objects in the natural environment.

Case Set 3-3: Cosmetic Surgery

To use motion geometry (slides, turns, flips) together with the process of dissection to transform any polygon into another polygon of the same area.

Case Set 3-4: Mutilated Posters

To use the concept of symmetry to help restore damaged symmetric figures (e.g. half of a square is missing)

Case Set 3-5: Fastidious Frank Phelon

To record and read time using date, hour, minutes, and seconds. To measure using mm and tonne and to relate tonne to litres and to linear measures. To use linear units appropriately.

Case Set 3-6: Balanced/Unbalanced Inmates

To classify figures according to lines of symmetry (reflective symmetry).

Case Set 3-7: Leaders in FlatHead Gangs

To estimate and measure the size of various polygons on the basis of perimeter and area and to discover relationships between area and perimeter.

Case Set 3-8: Tanimals

To construct various polygons (triangles, squares, rectangles, parallelograms, trapezoids, and so on) that can be made using tangram pieces, and to make "natural" outlines (animals, detectives) as well.

Case Set 3-9: Cover-up Caper

To find the area of various polygons using nonstandard as well as standard units.

Case Set 3-10: Guns and Bullets

To measure length in millimetres.

Math Objectives (Alberta Education)

This Section provides brief introductions to mathematical concepts and procedures which children will use to solve cases in the next Section. The concepts and procedures include using geometric nets to construct 3-D objects, using tangrams to construct polygons, using slides, flips and turns to transform polygons, constructing a measuring tool to detect differences as small as 1 mm, estimating and quantifying a tonne, exploring symmetry with a Mira.

This section involves the use of the problem solving approach to solve detective cases. As a result almost all of the problem solving objectives for grade five are covered here. In the process of solving cases, students develop and use all of the concepts of measurement, geometry and problem solving that are new for Level 7. As well many measurement and geometry concepts and skills from lower levels are also reviewed.

Specifically,

M8 reads and writes time, using standard notation to the nearest: second

M15 uses appropriate standard measuring units for length.

M17 expresses linear measures to the nearest thousandth of a metre by using manipulatives, where appropriate.

M29 uses appropriate standard measuring units for mass: kg, t

M44 finds and compares the perimeter of polygons by using manipulatives and diagrams (no formulas) in a problem-solving setting

M45 uses manipulatives and diagrams (no formulas) in a problem-solving setting to find and compare the area of rectangles

M46 demonstrates understanding of the relationship between perimeter and area by using manipulatives and diagrams to make rectangles:

- having the same perimeter but different areas
- having the same area but different perimeters

G7 classifies and names two-dimensional figures as pentagons, hexagons, octagon

G8 using nets to name: prisms, pyramids according to the types of bases.

- G16** demonstrates understanding of symmetry through identifying symmetric figures and drawing lines of symmetry on two-dimensional figures
- G17** drawing and identifying translations (slides) of two-dimensional figures
- G18** demonstrates understanding of rotations (turns) by manipulating two-dimensional figures
- P1** demonstrates willingness to find a solution to a problem
- P2** perseveres in finding a solution to a problem
- P3** demonstrates flexibility in finding solutions to problems
- P5** works both independently and in a group situation
- P8** interprets pictures and diagrams
- P10** restates the problem in own words
- P11** knows what information is implied
- P12** knows what information is missing
- P13** knows what information is extraneous
- P14** uses logical reasoning
- P17** looks for and continues patterns
- P18** draws pictures and diagrams
- P21** does a simpler but related problem
- P24** works problem backwards
- P25** states the answer(s) to the problem
- P26** determines if the answer is reasonable
- P27** discusses the solution process with others
- P28** looks for other ways to solve the problem
- P30** does similar problems
- P31** alters the problem and finds the effect
- P33** creates problems that exemplify the concepts learned.

Materials

In the kit:

- **Case Notes pads** – focus on as evidence building – and need to include in final report; provide **Copy Master** with same format as Bogdonavich – 5.5 x 8
- Squared FlatHead Grid
- Triangled FlatHead Grid
- Polygon Cutouts
- Case Note Pads
- Case Set packages, 2 copies each of 10 sets
- Mugline game
- What's My FlatHead game

You provide:

- straws (about 100 per group)
- string
- blank paper
- 1L milk cartons
- adding machine tape
- scissors or paper cutter

- tape (surgical tape will do)
- meter sticks or measuring tape useful for measuring meters
- regular rulers
- calculators
- drawing implements

Also useful:

- tangrams (3 or 4 sets if available)
- several MIRA

Preparation

1. Prepare the **Copy Masters** and gather the materials in advance. Decide where finished cases may be handed in – and a system for you to mark and record them.

Making several copies for each student of the following Copy Masters will be required: Make an ongoing stack of them!

3C – Conference Report for Detective Achievement and Reference

3-1D2 – Net Paper

2. Gather the materials for each Case Set. Monitor the materials piles and replenish them when get down.

3. Prepare the **TanGram FlatHead** sets. Students should each make and maintain their own **TanGram FlatHead Tool** set. You need to:

- provide a 10 cm x 10 cm square of heavy colored tag board (or ask that students draw, measure, and cut it).
- display a copy of it as illustrated on the **Copy Master: Tool Master 3-3A1: TanGram FlatHeads**

Students need to use a straight-edge and their observation and remembering skills to construct a set for themselves using your displayed version as model.

Use these whenever “tangrams” are needed.

Connections

Assessing and Monitoring

Periodically enter remarks about student interest and mathematical behavior in the Events-based Recordkeeping Charts (Copy Master Intro, F: Events-based Record-Keeping Chart), especially at the end of the section.

Assessment in Context Suggestions

The conferences scheduled for the end of each Case Set of work offer opportunities for assessment.

Conferencing

As detectives work, particularly on the banner, you might begin a round of conferences. Have detectives bring all their **Detective Logs** and previous **Conference Report** forms with them. You may want to introduce the **Conference Report for Detective Achievement and Reference** found on Copy Master 3C.

Emphasize the importance of their own suggestions about how to become better at solving cases. You may wish to focus upon one of the particular skills, such as what detectives understand about flips, turns and slides and the use they are making of these operations to solve current cases.

Recordkeeping

Update both Objectives-Based and Events-Based Recordkeeping Charts

Student Self-Assessment

Files

- **ParentFile:** Early in this Section you could inform parents that your young detectives are embarking on the adventure of solving a large number of Case Sets, and offer an invitation for them to visit. Part way through, send a newsletter that includes detectives' descriptions of their work, some examples of work in progress, and comments by students, for example.
- **LitFile**
- **ComputerFile**
- **PSFile**
- **TestItemFile**

Ongoing Events

A Mobile as a Storage Facility: It will be difficult for detectives to store their paper prisms in their folder. A neat way of storing their "captured" prisms is to "hang" them as a mobile. Each detective could make a mobile and add new prisms to it as they proceed with their cases. Each mobile would be a "gallery of rogues!"

Cosmetic Surgery Banners: See notes and directions for Case Set 3-3.

Origami Hexahedron: See **Copy Master 3-1E1** and Integration Opportunities below.

Games and Puzzles

- **Copy Masters**
 - Puzzle 3D1: Practice in Code Breaking I** (a measurement crossword puzzle)
 - Puzzle 3D2: Practice in Code Breaking II** (a geometry crossword puzzle)
- Games provided in kit:
 - Game: **What's My Mugline**
 - Game: **What's My FlatHead**
 - Problem Book:** Make cross-word puzzles, games, and cases of their own
 - Puzzles:** Tangrams are a great source of puzzles. See for example:
Bright, G., & Harvey, J. (1988). "Learning and fun with geometry games," *Arithmetic Teacher* 35 (8) 22-26.
Contains games that provide excellent experience with prisms and pyramids.
 - Jensen, R. (1984). "Multilevel metric games," *Arithmetic Teacher*, 32 (2) 36-39.
A variety of games to provide practice with metric units of length.
 - Kriegler, S. (1991). "The tangram is more than an ancient puzzle," *Arithmetic Teacher* 39 (9) 38-43.

A host of activities in amenable to Case format, relating tangrams to graphing. Provides multiple solutions to problems as well.

Read, R. C. (1965). *Tangrams – 330 Puzzles*. New York: Dover.

Sicklick, F., Turkel, S. & Curcio, F. (1988). "The 'transformation' game," *Arithmetic Teacher* 36 (2) 37-41.

Describes a game that provides fun experience with slides, flips and turns. Perhaps the detectives could make the game as a project.

Tangrams: Excellent tangram cases can be found in:

Dunkels, A. (1990). "Making and exploring Tangrams," *Arithmetic Teacher* 37 (6) 38-42. Provides a guided approach to making tangrams from paper folding and cutting.

Irons, C. & Irons, R. (1991). Cut to create. *Arithmetic Teacher* 39 (3) 25-33.

Five excellent activities that are ready made as follow through cases on the Tangram lesson.

Geometric Figures: A variation on capturing prisms and pyramids can be pursued with pipe-cleaners. Some excellent suggestions for this can be found in: Prentice, G. (1989). "Flexible straws," *Arithmetic Teacher*, 37 (3) 4-5. (A set of tips and techniques for using straws and pipe-cleaners to show geometric properties of figures.)

Culminating Presentation: Résumés. Created Cases.

Student Dictionary: Ideas in **Appendix H: Illustrated Math Dictionary**

Ask Me Logbook.

Integration Opportunities

STS Issues

- **Guns.** Gun control, laws; hunting, target practice; military, police, defense. Do these work in our society?
- **The making of crime,** the technology of punishment. When does an action or activity become a crime? Who decides? If there is no rule against an action, can it be a crime? What is crime? How can a crime be committed "against the people" or "against the state"? Why do you think people "commit crimes"? (Ericson, 1981; Zonderman, 1990).
- **Information and Privacy.** Should individual rights and freedoms be secondary to prevention of crime? What crimes? All crimes? Are some issues more important than others? Should investigators be allowed to lie about their identity and purpose in order to gain information? How do you feel about the words, "interrogation", or "suspect"? How would you feel if you knew you were "under surveillance"? (Zonderman, 1990)

Social Studies, Science, Fine Arts, Music

Suggestions for integration with the "real world" can be found in:

Jenkins, L. & McLean, P. (1971). *It's a tangram world*. San Leandro, CA: Educational Science Publishers.

Interesting activities integrated with music, games, story problems and geography.

Shubnikov, A. (1974). *Symmetry in science and art*. London: Plenum Press.

A fine reference for integrating symmetry with art and science.

Games

- *Clue*

Fine Arts

Origami (Japanese paper folding) is an artistic way of constructing geometric figures. A hexahedron can be made from a square sheet of paper through paper folding. See **Case Set 3-1** and **Copy Master 3-1E1** for instructions. The steps are a little intricate but with careful guidance it can be done by grade five children. It's a good idea to make one yourself before hand! The following articles provide an excellent source of Japanese paper folding activities and ideas. As well they provide a prelude to the concept of symmetry to come.

Heukerott, P. (1988). "Origami: Paper folding – the algorithmic way," *Arithmetic Teacher* 35 (5) 4-8.

If some of the detectives become enthused about solving the origami problem, this article might lead them into other activities and references.

Kawaii, T. (1984). *Colorful Origami*. New York: Barnes & Noble.

Origami done by someone with a Japanese mind.

Pattern. Create Escher-like patterns as shown for example in the *Arithmetic Teacher* 1990 38 (1) 6-12.

The graphic art of M.C. Escher is particularly appropriate as an artistic interpretation of motion geometry. Suggestions can be found in:

Giganti, P. & Cittadino, M. (1990). "The art of tessellation," *Arithmetic Teacher* 37 (7) 6-16.

The best introduction to tessellations through Escher-like patterns that we have seen in some time. Full of activities and wise counsel as well as extensive references, and includes a glossary too.)

Taylor, L., Stevens, E., Peregoy, V. Bath, B. (1991). "American Indians, mathematical attitudes and the Standards," *Arithmetic Teacher* 38 (6) 14-21.

Native arts and crafts are in part presented through Escher-like patterns.

Symmetry.

Zaslavsky, Claudia. (1990). "Symmetry in American folk art," *Arithmetic Teacher* 38 (1) 6-12.

Many examples illustrate Escher-like patterns.

Shubnikov, A. (1974). *Symmetry in science and art*. London: Plenum Press.

A fine reference for integrating symmetry with art and science.

Language Arts

- **Communication.** Discussion of case work.
- **Communication.** Prepare responses to the letters included in the case information.
- **Case Writing.** Encourage students to create their own cases.
- **Clear communication.** Write instructions for origami.

Computing

LOGO. Use LOGO in geometry cases

If you have access to LOGO, the following articles provide suggestions as to how prisms and pyramids can be done in LOGO.

Syroi, R.J. (1990). "Communicating about spatial relationships," *Arithmetic Teacher* 37 (6) 21-23. (Relates prisms and pyramids to LOGO).

Mathematics in This Section

Section 3 is the major section in the *Detective Agency Module*. The bulk of the mathematics is learned here, and it all happens while solving cases. Each math concept or skill is developed in the context of doing detective work and therefore the details of how each concept is connected to particular cases is discussed in detail in the notes for each Case Set below.

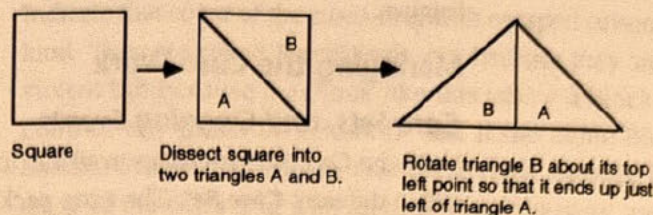
This Section has a number of novel approaches to the mathematical content. The most novel of these approaches is **Dissection-Motion Operations**, and is described here in some detail.

Motion Geometry

Dissection-Motion Operations is a relatively new approach to geometry, and yet its basic concepts are simply those of dissecting (folding and cutting), rotating, flipping, and sliding. These operations can be introduced as a way of disguising FlatHeads – a way of transforming themselves into a different appearance, yet still somehow remaining the same. What remains the same is the area of the polygon, and so it is said that dissection-motion operations are "area preserving."

1. Motion Geometry at the grade five level involves three major operations:
 - Reflections** (flips: flipping an object over — as in flipping a coin, heads becomes tails)
 - Rotations** (turns: turning an object with respect to a point of turning — as a door turns about its hinge)
 - Translations** (slides: sliding in a straight line — as a snow shovel is pushed ahead)
2. Whenever an object is operated upon using flips, turns, or slides, the object doesn't change very much — a door is still a door when it is rotated, but it may now be closed whereas it might have been open before. The door may "look" a little different but it is still the same. In fact it is congruent to itself.
3. Because flipping, turning, and sliding only change "appearances" we can think of them as "cosmetic surgery" — only the looks have changed. In this way, students can learn motion geometry as a way of understanding how "BlockHeads" or "FlatHeads" disguise themselves (change their identities)

through cosmetic surgery. To make it all work we only need one more operation – a *dissecting* operation. With it, we can “cut a thing up” (i.e., dissect) and then relocate the pieces through flipping, turning, or sliding. An example of cosmetic surgery through motion geometry is illustrated below. In this case a square is being transformed into a triangle.



Changing the identity of a square through cosmetic surgery

4. The procedures illustrated above, called “Dissection-Motion Operations” have only recently been introduced to school geometry, but they are a powerful yet simple way of dealing with motion geometry (flips, turns and slides). The name “Dissection-Motion Operations” is quite descriptive: the word “dissection” refers to *cutting* the shape into two pieces and the word “motion” refers to *flipping, turning, or sliding* one of the pieces into a new location. With these two operations (dissecting and moving) we can change any polygon (square, triangle, rectangle, etc.) into any other polygon. Notice that the dissection line can always be determined by *folding* the paper.
5. Should you be interested in further background information, the following references may be of interest to you:

Rahim, M. & Sawada, D. (1986). “Revitalizing school geometry through Dissection-Motion Operations,” *School Science and Mathematics*, 86, 235-246.

Rahim, M. & Sawada, D. (1989). “Inventing Tangrams through Dissection-Motion-geometry,” *School Science and Mathematics*, 89, 113-129.

Teaching in This Section

Organization of the Classroom

Detective Teams

This Section is organized so that individual detectives, detective pairs, or small teams of detectives may work independently on a series of Case Sets.

Materials

Prepare all the materials for this Section in advance and house them where students will be able to access them easily. Because this Section is lengthy and some materials will be used often, you will need to be aware of dwindling resources and replenish them as needed. Organizing the materials and their storage could be part of the detectives responsibility as well.

Case Sets

Each Case Set contains several related cases intended to be done as a series. The Case Sets may be done in any order although the Cases within each set should

be done in order. Two copies of each Case Set package is provided. Some require **Copy Masters**.

You will want to provide materials for students to be making their own cases or Case Sets in preparation for the culminating event. This creation of their own cases may be an ongoing event, and the cases produced may be solved by colleagues.

Managing the Case Work

Case Sets, and Ongoing Events

Make the Case Sets packages available to the detectives. Each team should start with a different **Case Set**. The extra packages will ensure that no detective team is left without a Case Set available. If, however, there are times when materials or Case Sets are in short supply, turn the detectives to **Ongoing Events** activities.

Case Reports

Teams will share materials but each detective will write his/her own Case Report(s) on his/her own paper (a computer would be useful). Some Case Sets contain more than one case to be solved, and therefore, may need more than one Case Report. The Case Report(s) with all the gathered evidence including completed **Copy Masters** and **Case Notes** appended should be handed in as a unit of work. After assessing it, you could file it in the same set of file folders you have for keeping anecdotal records, or you could create another set of file folders, one per student, to house these Case Sets Reports – an Agency File with a folder for each agent!. You may also create a chart somewhere where Case Sets are checked as they are completed.

The detectives' ongoing work on Case Sets could be housed in the **Student Folder**. One of the detectives in each team will need to be responsible for the Case Set package/envelope while it is in use.

Introducing the Case Work

So that all detectives can begin working on any of the cases, you will want to familiarize your detectives with some of the key ideas that flow through many of the cases.

Origin of the Case Sets

Inform detectives that the Case Sets they will be working on have been handed down to them through these circumstances:

1. Lone Star Detective & Investigators Inc. has gone bankrupt (reasons unknown).
2. Our Agency has been assigned to complete the cases that were in progress. Most of the cases have some work already done, some evidence gathered, and include notes by the investigator who was assigned to the case (Detective Bogdonovich).
3. Many of the investigations were being done for the Warden of the Federal Penitentiary. The investigators were (and will be) having to do tasks like:
 - making wanted posters
 - creating and figuring out disguises

- capturing prisoners who have escaped from prison
- diagnosing inmates

Briefing on the Cases

Spend a few minutes briefing your detectives on the following terms:

1. BlockHeads

Indicate that some of the cases deal with escaped prisoners of a very special kind. They are called BlockHeads, not because they are necessarily bad or violent but because they look like this (show a block of wood such as a cube or any prism or pyramid). Ask if the name BlockHead is fitting. Indicate that several of these BlockHeads have escaped from prison and that many of the cases deal with making wanted posters, and with ways of capturing them.

2. FlatHeads

Ask what a FlatHead, a cousin of the BlockHead, might look like. You may wish to show some example FlatHeads (any polygon from the Tangram set will do). Ask how they are similar to their cousins and how they are different. Indicate that in many of the cases, FlatHeads are masters of disguise. Figuring out how FlatHeads disguise themselves, and the catching them in disguise will be important in solving some of the cases.

3. Tangrams

These are a special kind of FlatHead. You may wish to point out that detectives will use tangrams in a very special way – to make wanted posters for FlatHeads.

4. MIRA

Indicate that in ordinary math classes this piece of equipment is called MIRA, but in this detective work it is called “Ultra-Red Sensing Technology,” or URST. It has a very special property: It is like a mirror but different in that it can be seen through. It is used to draw things that can be seen in the mirror. It will be used to diagnose the degree of balance of various FlatHeads before assigning them to a Cell Block. If you like, you may wish to illustrate how URST can be used to complete wanted posters that have been torn (see **Case 3-4**, “Mutilated Posters”).

5. Nets

Students have likely encountered nets before but show them that in this detective work, a net is just a bunch of dots (a network of dots) that will be used to draw wanted posters, and later to capture BlockHeads. Show an example poster, perhaps a poster of “Hexy” from **Case 3-1**.

Ask: “Who is “Hexy”?” “Any aliases?” [hexahedron, cube, block]

“How can it be that this a poster of Hexy?”

Show a pair of scissors and ask if they can be used to help prove that this is a poster of Hexy.

This brief familiarization with some of the key terms involved in the cases should enable detectives to begin with any Case Set. If you think further briefing is needed, you may want to select further examples from the Cases.

During Case Work

The Detective Notebook

Detectives will be expected to manage their own notebooks, to keep them accurate and organized. They will use their gathered material to write their Case Reports – so will need to keep all notes, scraps of paper, photocopied pages, and so on.

"An investigator's notebook is his most important investigative tool." (*Buckwalter, 1984, p. 59*)

The investigator's notebook is "the basis for investigator's testimony in a court of law." (*Buckwalter, 1984, p. 59*)

"The private investigator's records from handwritten notes, sketches, photographs, slides moving pictures, or diagrams are the best recall aids. Without accurate and complete records the private investigators are "sunk." (*Buckwalter, 1984, p. 59*)

Mini-Lessons

Monitor the ongoing work for misplaced understandings, and hold mini-lessons as needed. If a number of students are struggling with a particular concept, call them together in a corner of the room and hold a "Briefing Session."

Assemblies

Several times throughout the Section choose opportune times to hold general Assemblies. They may be very short or longer. They may be offered as an opportunity to share how the work is going and/or what it means to be a detective. They may be held to stimulate interest, to talk about the culminating event, or to discuss a particular problem or finding such as "How did you decide when you had a complete set of disguises." Check the **Ongoing Events** of this Section for other activities that would function as breaks or holidays from the detective-work.

When a Case Set is Finished

Conferences

Once a team is finished with a Case Set (or more often, of course), they may request a conference with you, the Chief Detective. If necessary, each member of the group may be required to understand all the cases before the group may call a conference! They or you should bring their completed Case Set to the conference. Fill in a **Conference Report (Copy Master 3C)** during or immediately after each Conference. These reports will become "references" for the résumé in the culminating event. Detectives may be given their **Conference Reports** to save in their **Résumé Folders**.

You may call a conference as well.

Summary of Case Work Plan

The Section has three parts, which will be *simultaneously* part of the process of solving the Case Sets. Students will be:

1. Working on Cases

- a. Getting to know the case
- b. Gathering evidence
 - Make and carry out plans/ideas/hunches/clues/evidence
 - Follow leads, analyze evidence, gather data, etc.
- c. Writing and filing a case report – all manner of first-hand data appended.
 - The point is to convince the Chief Detective that you actually did some work on this – part of “getting paid” in an agency

2. Going to the Chief for Conferencing:

- After a Case Set is complete and each member of the group understands all the cases, the group requests a conference

3. Calling and attending Assemblies:

- a. Impromptu Assemblies are very important and could be:
 - 30 minutes about twice a week, or;
 - many quick ones, 5 to 15 minutes each
- b. Planned Assemblies could be once or more per week:
 - planned by the Chief or;
 - requested by detective(s)

Extension

(2 hours or more)

As detectives finish the Case Sets provided, encourage them to create **Culminating Case Sets**. They could form detective teams, make up a mini-case set (e.g. one case each with a common “theme” per group), and then offer them to the rest of the agency. These could then be added to the Case Sets — a Problem Book for the agency.

As detectives finish all of the case sets, or in between cases, provide activities suggested in Ongoing Events of this Section, and suggest continuing work on résumés and development of cases for the culminating event which will be next. For yourself, look ahead to the Looking Back and Looking Ahead components of this section.

Case Set 3-1: Wanted: Hexy

Materials

In the kit:

- Case Set package: pages 3-1A, 3-1B, 3-1C, 3-1D, 3-1E

You provide:

- string
- straws
- scissors (one pair per team)
- squares (8.5 x 8.5 inches works well), one per student

Copy Masters:

Poster Form for **Case 3-1D1: Wanted, the Hexahedron**, one copy per student

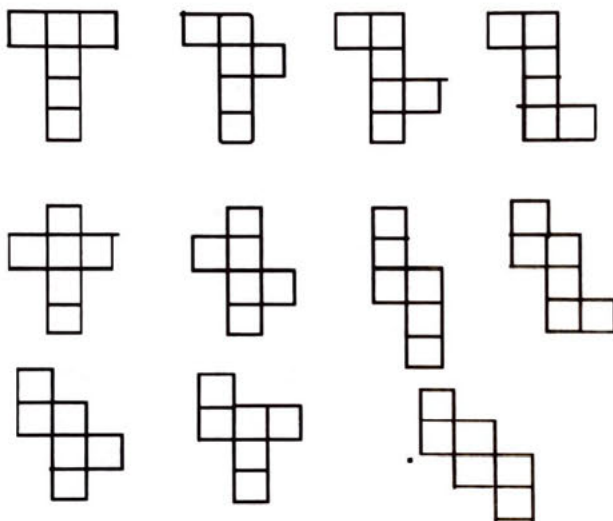
Net Form for **Case 3-1D2: Net Paper**, several copies per student

Exhibit for **Case 3-1E1: Origami Hexahedron**, 2 pages, one copy

Notes on Solving the Case

"AKA" is short for "also known as"

Here is a complete set of Posters for the Hexahedron.



If students think they have a different poster have them see if by *flipping* or rotating they can get it to be one of the above. If they can, then it isn't really different – just different by a flip or turn. **Case 3-3** (Cosmetic Surgery) provides experiences with flips, turns and slides. The idea for using the term "cosmetic surgery" is that by flipping, turning or sliding nothing really different is produced – just changes in appearance.

If your students find a poster which is not included in the above set, please contact the publisher. We would like to hear about it.

Origami Hexahedron

The only material you need is a square sheet of paper for each detective. Notice that the diagrams on the first sheet do not have instructions. A good communicative task for detectives is to write the instructions for this sheet after they have solved the case.

Aside: Paper folding (like good detective work) requires a careful and attentive attitude. Sloppy work leads a sloppy solution! Perhaps these points might come up in discussion of their paper folding experience.

In Between Cases

Some suggestions for further exploration:

DMP (Geometry Division II) has materials for making a clever activity called "Holes" which requires students to make structural predictions about the locations of holes in a hexahedron. Details and directions are found on pp. 134-136.

Case Set 3-2: Capturing BlockHeads

Materials

In the kit:

- **Case Set** package: pages 3-2A, 3-2B, 3-2C, 3-2D

You provide:

- scissors
- tape
- **Copy Masters:**

Net Form for Case 3-1D2: Net Paper, several copies per student

Nets for Case 3-2A1, 7 pages, one copy per student

For your information, the contents are:

3-2a1 page 1: triangular-based prism, pentagonal-based prism

3-2a1 page 2: square-based prism, rectangular-based prism

3-2a1 page 3: square-based pyramids, pentagonal-based pyramid

3-2a1 page 4: triangular-based pyramids, rectangular-based pyramid

3-2a1 page 5: octahedron

3-2a1 page 6: cone

3-2a1 page 7: cylinder

Notes on Solving the Case

A pyramid can be more easily distinguished from a prism when both are seen as standing on a base. Then the top of the pyramid is a point where the sides (all triangles) meet; the top of the prism is the same as its base and the sides (all rectangles) stand up vertically joining the base to the top.

The chart below might help in quickly (as in a glance) distinguishing pyramids from prisms:

	No. of bases	type of sides	orientation of sides	Shape of "top"
pyramid	1	triangles	slanting in	point
prism	2	rectangles	vertical	same as base

In Between Cases

Some suggestions for further exploration:

DMP (Geometry Division II) has materials for making two interesting games that are excellent extensions and review of the ideas in this case:

- **Geobingo** pp. 80-85
- **Triple Match** pp. 89-94

For both of these activities you might have students help to make the games from the materials provided on these pages.

Case Set 3-3: Cosmetic Surgery

Materials

In the kit:

- **Polygon Cutouts**, previously cut apart in Lesson 1-3 may be used as a trace-around template
- **Case Set** package: pages 3-3A, 3-3B, 3-3C, and 3-3AT1, 3-3AT2, 3-3AT3, 3-3AT4

You provide:

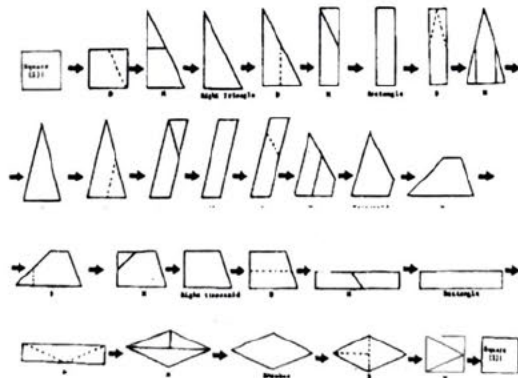
- scissors
- tape
- adding machine tape for banner (or similar roll, larger than this may be better)
- A template to make paper triangles, squares, rectangles, parallelograms, trapezoids.
- **Copy Masters:**
Tools Master 3-3A1: TanGram FlatHeads, one copy for display
Tools Master 3-3A2: Some FlatHead Triangles, one copy per student

Notes on Solving the Case

Detectives should have the Polygon Cutouts from Lesson 1-3 as "templates" to make paper triangles, squares, rectangles, parallelograms, trapezoids. They should be paper so they may be cut/dissected.

Making a Cosmetic Surgery Banner

The idea is to construct an "artistic banner" made up of a long strip of adding machine tape. The banner would depict the journey of a square as it changed into a whole series of different shapes but never into a square again until it returned to its starting point (the square returning home again). An abbreviated journey is shown below.



A short journey of a square who eventually returned "home."

This could also be an Ongoing Event that can be completed in a number of ways.

Each detective team might construct a portion (leg) of the journey. For example:

- Leg 1: from a square to a triangle with several "stop over" places,
- Leg 2: from a triangle to a rectangle with several stop overs,
- Leg 3: from a rectangle to a parallelogram with several stop overs,
- Leg 4: from a parallelogram to a trapezoid with several stop overs,
- Leg 5: from a trapezoid back to the original square.

These legs could then be pinned together and "circulated" around a portion of the agency.

In Between Cases

Some suggestions for further exploration:

DMP (Geometry Division II) has materials for making:

- eight fun activities involving the use of **MIRA** (AKA URST) to carry out some very interesting transformations of real world events and objects. Called "Mira Magic," the activities can be found on pp. 145-151
- three activities involving *flips*, *turns*, and *slides* called:
- Slides, Flips, Turns – pp. 155-158
- Flip Out – pp. 159-160
- Alphabet Soup – pp. 161-164

Woodward, E. & Buckner, P. (1987). "Reflections and Symmetry – A second-grade mini unit," *Arithmetic Teacher*, 35 (2) 8-11.

Although aimed at the second grade, this article provides an excellent introduction to the use of the Mira that would be appropriate and fun for level 7 students using Mira for the first time.

Bidwell, J. (1987). "Using Reflections to find symmetric and asymmetric patterns," *Arithmetic Teacher* 34 (7) 10-15.

Explores symmetry through the use of a mirror.)

Case Set 3-4: Mutilated Posters

Materials

In the kit:

- Case Set package: pages 3-4A, 3-4B

You provide:

- several Miras, labeled URST
- **Copy Masters:** one copy per student

Poster 3-4A1: The James Gang

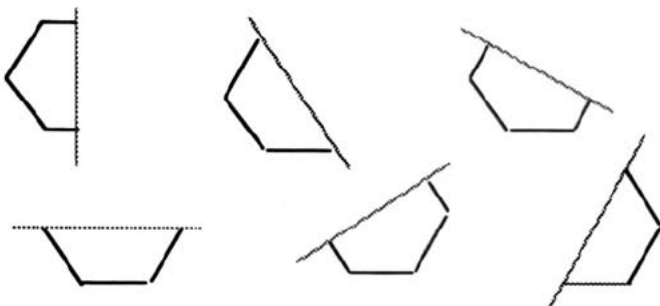
Poster 3-4A2: The Gifford Gang

Poster 3-4A3: The Geo Gang

Poster 3-4A4: The Hexagon

Notes on Solving the Case

For the regular hexagon six different lines of symmetry allow for six restorations:



For the octagon, eight different lines of symmetry allow eight different restorations

In Between Cases

Some suggestions for further exploration:

DMP (Geometry Division II) has materials for making three interesting activities that involve a search for 2-D shapes in a collage of shapes:

- **Where Am I?** version 1 p. 115
- **Where Am I?** version 2 p. 116
- **Where Am I?** version 3 p. 117

Making the activities from the materials provided on these pages will be a good learning experience for students as well.

There are also eight fun activities involving the use of Mira (AKA URST) to carry out some very interesting transformations of real world events and objects. Called "Mira Magic" the activities can be found on pp. 145-152. Particularly appropriate for **Case 3-4** is the activity on page 152.

Case Set 3-5: Fastidious Frank Phelon

Materials

In the kit:

- Case Set package: pages 3-5A, 3-5B, 3-5C, 3-5D, 3-5E, 3-5F, 3-5G and exhibits 3-5C1, 3-5D1, 3-5E1, 3-5F1

You provide:

- milk cartons (1 L)

Notes on Solving the Case

Fanatically fastidious means that Frank is paying close attention to differences as small as a millimeter. Because all the stolen articles measure an even number of units, this robbery is contrary to the Frank's modus operandi. It is likely therefore (and even the judge admitted this) that he was not the guilty party. The time information is a red herring (extraneous information).

Frankly: Again because the stolen articles all measure an even number of cm the robbery is not likely Franks.

Milk cartons: Each arrangement of milk cartons provides an even number of kg and so Frank was not the guilty party. Likewise the nearest tonnage is also even as shown in the table.

The capacities rounded to the nearest tonne are as follows:

	load (in cartons)	kg	nearest tonne
Truck 1	60 x 100	6000	6
Truck 2	53 x 120	6360	6
Truck 3	44 x 129	5676	6
Truck 4	73 x 136	9928	10
Truck 5	23 x 90	2070	2
Truck 6	40 x 100	4000	4

Frank's Classroom: All the other rooms have odd length and width and so any of them would be compatible with Frank's odd disposition. The area of each is also odd.

In Between Cases

Some suggestions for further exploration:

A Matching Activity:

DMP (Measurement Division II) has materials for making a matching activity called "Unit Matching" which provides further experience with the appropriate use of length units. Directions and materials can be found on pp. 115-118

Case Set 3-6:

Balanced/Unbalanced Inmates

Materials

In the kit:

- Case Set package: pages 3-6A, 3-6B, 3-6C, 3-6D

You provide:

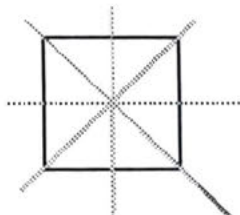
- several Miras, labeled URST
- **Copy Masters:** one copy per student
- **Exhibit 3-6A1: New FlatHeads**

Notes on Solving the Case

"RectoHead" has two lines of symmetry:



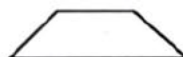
The square has four lines of symmetry and so should be assigned to Cell Block 4.



FlatHead assignment to Cell Blocks:



Cell Block 0



Cell Block 1



Cell Block 1



Cell Block 3



Cell Block 2



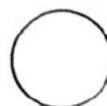
Cell Block 0



Cell Block 6



Cell Block 5



Cell Block 7

The circle has infinite lines of symmetry because every line through the centre is a line of symmetry.

The most balanced inmates would be the ones with the greatest symmetry so occupants of Cell Block 8 (and any higher Cell Block) would be the more balanced.

In Between Cases

Some suggestions for further exploration:

A Symmetry Game:

DMP (Geometry Division II) has materials for making a symmetry game called "Fun With Cubes" which provides further experience with the idea of symmetry. Directions and materials can be found on pp. 153-154.

Case Set 3-7: Leaders in FlatHead Gangs

Materials

In the kit:

- Squared FlatHead Grids
- Triangled FlatHead Grids
- Case Set package: pages 3-7A, 3-7B, 3-7C and exhibits 3-7C1, 3-7C2

You provide:

- **Copy Masters:** one copy per student
- **Poster 3-7C3: MasterMind Poster**

Notes on Solving the Case

In discussing this case with your detectives you may wish to talk about “hat size” as *perimeter* and “room inside” as *area*.

The dilemma of the Warden can be resolved by detectives if they then discover that FlatHeads with the same perimeter can have different areas.

Gang of Seven: Likely leader is the square because among these seven polygons the square has the most room inside for a given hat size. The long narrow rectangle would have much less room for a brain than the square. Actually a regular pentagon would even have more room inside than a square of the same perimeter (hat size). A regular hexagon of the same hat size would have an even larger area.

Encourage students to use the grids to see if they can tell which shape of FlatHead has the most room inside for a brain. A comparison of the long narrow rectangle with the more “normal” rectangle and with the square should lead to some generalizations about which has the largest “cranial capacity.”

If a quick glance is all that the detective has time for, he would likely look for a figure for which the width and length are about the same. Such a FlatHead is likely to be the leader. A tall and skinny (or low and very wide) Head would have little space for a large brain. Round heads have the greatest cranial capacity (among FlatHeads that is!). No matter how you look at them, RoundHeads are about as wide as they are high.

Master Mind of all MasterMinds: The Master Mind of all MasterMinds, as you have likely deduced, would be the circle. The circle has the maximum area for any given circumference. In a sense then, the perfect shape for a FlatHead is to be perfectly round. A circle also has infinite lines of symmetry and so is the most balanced. This is probably a good combination for a leader – level headed and with a big brain.

Case Set 3-8: Tanimals

Materials

In the kit:

- Case Set package: pages 3-8A, 3-8B and exhibit 3-8A1

You provide:

- tangrams
- **Copy Masters:** one or more copies per student
- **Poster 3-8A2: Tanimal Poster**

Notes on Solving the Case

See DMP (Geometry Division II) pp. 118-128 for several examples of Tanimals.

In Between Cases

Some suggestions for further exploration:

DMP (Geometry Division II) has materials for making four tangram activities that are excellent extensions and review of the ideas in this case:

- **Exploration** (of tangrams)
- **Create a Design**
- **Copy a Design**
- **Classify and Name**

All of these activities and the materials to make them are on pp. 118-128. Included are several clever "Tanimals."

Case Set 3-9: Cover-up Caper

Materials

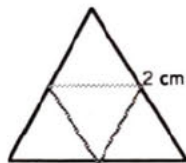
In the kit:

- Case Set package: pages 3-9A, 3-9B and exhibits 3-9A1, 3-9B1, 3-9B2

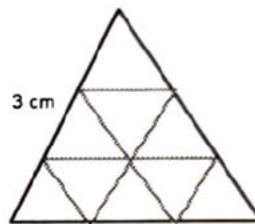
Notes on Solving the Case

It is likely that the FlatHeads know exactly how many units to send to do a complete cover-up because they first figure out the *area* of the poster.

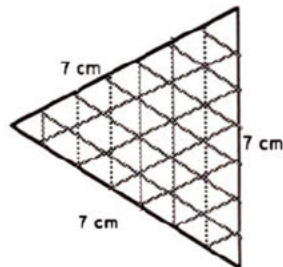
For the equilateral triangles, the number of pieces needed to cover the posters is illustrated below:



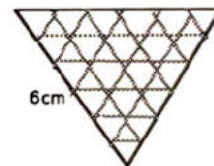
4 "square" units



9 "square" units



49 "square" units



36 "square" units

Case Set 3-10: Guns and Bullets

Materials

In the kit:

- Case Set package: pages 3-10A, 3-10B, 3-10C

You provide:

- **Copy Masters:** one or more copies per student
Chart 3-10A1: Chart of Bullets

Quotes of the Day:

"Contrary to filmed stories, most private investigators have never been shot at in their lives. In fact, the majority of them are unarmed, they carry no concealed weapons. Private investigators use their heads rather than guns. Their forte is know-how." (*Buckwalter, 1984, p. 9*)

Notes on Solving the Case

Bullets









A "44 Magnum" is an indication of the caliber of the firearm. The caliber is the inside diameter of the gun barrel or the diameter of the bullet. Because the United States is a large manufacturer of firearms, most of the calibration is done in inches. Thus a 44 Magnum has a barrel with a diameter of .44 inch. The bullets would also have a .44 inch diameter (approximately). Dirty Harry used a 44 Magnum. It is a powerful weapon. Enough to "make my day."

A "38 Police Special" would fire bullets with diameter .38 inch. Thus a "38" is a smaller firearm than a "44."

Some European firearms are metric in design. For example a 9 mm Luger is a popular firearm with metric calibration. It is a little smaller than a 38. From this we can deduce that .38 inch is a little bigger than 9 mm.

The chart begun by Investigator Bagdonovich is completed below. If students have rounded the metric calibration to the nearest mm that degree of precision should be adequate for this chart.

Chart of Bullets

Name Inch	Name mm	Picture(s) of bullets	Type of Firearm	Common name of Firearm
22	5.6		usually a rifle; some handguns	"twenty two"
243	6		rifle	Was often used for "varmint" hunting
270	7			high powered big game hunting rifle but the bullet itself is rather small.
30	7.5		rifle	e.g. "30-30" Most famous model was the Winchester Carbine 66 (1866)
320	8		rifle	32 Remington
38	9.6		revolver	9 mm Luger 38 Smith & Wesson
44	11.2		revolver	44 Magnum
45	11.4		revolver	Colt 45 – the gun that "tamed" the wild frontier.

References for the Case

Masini, S. & Rotasso, G. (1988). *Complete Book of Firearms*. New York: Portland House.

Plenty of pictures and provides a historical presentation. And for an American book it provides lots of metric information. Also has a nice succinct glossary if you care to sharpen firearms vocabulary.

Newton, M. (1990). *Armed and Dangerous: A writer's guide to weapons*.

Cincinnati: Writer's Digest Books. If you don't want to get caught saying silly things about guns such as "He picked the 45 Magnum up by its barrel" (there is no such weapon – a 44 Magnum perhaps as used by "Dirty Harry" but no 45 Magnum), then this book should be perused.

In Between Cases

Some suggestions for further exploration:

DMP (Measurement Division II) has materials for making two activities which provides further experience with the use of equivalent length units:

- Equivalent Linear Measures (pp. 168-169) provides practice in estimating and measuring common objects in mm and cm.
- Domino Length (pp. 170-173) is a domino-like game that provides practice with expressing equivalent length units.

Looking Back

Part 1. Assembly



Whole Class Activity

At least a short Assembly would be useful to summarize the experience of conducting investigations. Allow detectives to talk about the experience as a whole: what they liked, what they found exciting, what was a bother/mundane.

Draw out that a real-life detective would experience a wide variety of cases and situations in his/her daily work and in so doing would have gained much experience and learned a variety of skills.

It may be useful to return to the ongoing list of detective skills you have been charting, to stimulate discussion of real-world connections.

This is a summative time, when detectives come forward with their excitement as well as their questions and concerns.

Part 2. Celebration:

To celebrate one of the techniques, and as a way of reviewing motion geometry, make another Cosmetic Surgery Banner. (see Notes for Case 3-3: Cosmetic Surgery).

Looking Ahead

The next Section is the final one for the *Detective Agency* and students will be completing and presenting their résumés. You may have developed other plans as well. This is a time to complete those plans, and to talk about how your agency will celebrate (and close).

Section 4:

Presenting

Section Summary

Duration

2-3 hours

Storyline

Detectives started their résumés in Section 2 and have been collecting data (notes and conference reports, for example) throughout the Module. In this Section they have an opportunity to pick a few important aspects and highlight them.

As well, they have been writing cases of their own creation throughout. Here they are given opportunity to present an exemplary case to their colleagues in "science fair" fashion. It is a celebration of their skills and accomplishments as a detective.

Math Purpose

Lesson 4-1: Personal Profile

To collect, arrange, and display data as a way of monitoring an ongoing problem solving process and to culminate it with a presentation.

Lesson 4-2: Case Fair/Detective Show

To experience a problem from the perspective of an author so that the circumstances that give rise to the solution must be anticipated and specified.

Math Objectives (Alberta Education)

Collects facts and other data to solve a problem. By adopting the perspective of a writer of problems, experiences the need to be clear about how a problem is set up and written. In writing the real-world context for the problem must connect the mathematics involved to everyday experiences in a meaningful way.

Specifically,

- P5** works both independently and in a group situation
- P13** knows what information is extraneous
- P24** monitors the process in carrying out the plan.
- P24** works problem backwards
- P26** determines if the answer is reasonable
- P27** discusses the solution process with others
- P31** alters the problem and finds the effect

Materials

In the kit:

- Bulletin Board Bag

Poses: a surveillance scene

a scene-magnifying glass at a set of fingerprints, or ???

a wanted poster

You provide:

- paper of various sizes and felt pens for recording brainstorming ideas, sketching charts, graphs, and other visual presentation ideas, etc. A pad of chart paper would be useful.

Preparation

1. Arrange for guests if desired
2. Set up "booths" or areas where detectives can each set up their Case Presentation

Connections

Assessing and Monitoring

Periodically enter remarks about student interest and mathematical behavior in the Events-Based Record-Keeping Charts (Copy Master Intro. F: Events-based Recordkeeping Chart) especially at the end of the section.

Assessment in Context Suggestions

- Recordkeeping: Update both Objectives-Based and Events-Based Record-Keeping Charts
- Student Self-Assessment

Files

- **ParentFile**
- **ComputerFile**
- **LitFile**
- **PSFile**
- **TestItemFile**

Ongoing Events

- **Student Folders:** Clean up and collate material stored here, select material for class Portfolio and compile the rest into booklet form.
- **AskMe Logbook:** Make final entries, which may be lengthy.
- **Student Dictionary**

Integration Opportunities

Language Arts: Writing and sharing of writing.

Health: Careers.

Mathematics in This Section

The mathematics of this section is connected with two culminating experiences:

- putting together a résumé that celebrates all the skills and understandings acquired during this module. The major mathematical concepts involved in this culmination are therefore those of data collection, arranging and presentation. The data they present is in a sense themselves. They produce the evidence, collect it, arrange it, and then share it as a way of "marketing themselves."
- creating (writing) a case for others to solve. In doing this, students will be seeing the case from the perspective of an author. They will be setting up the problem situation so that the problem can be solved in anticipated ways. This experience of creating a case often forces students to work backwards from the "answer" trying to establish the facts and circumstances that make that answer reasonable if not cogent. Thus the major mathematical processes in this activity are those of problem creation and problem-solving.

Lesson 4-1: Personal Profile

Duration

1 or 2 hours

Materials

In the kit:

- Detective Kodak Photo-CD, provided

You provide:

- Stapler or colored string to bind booklets (optional)
- **Copy Masters:** (optional)

Intro.E Cover #1: A Surveillance Scene

Intro.F Cover #2: A Magnifying Glass Scene

Intro.G Cover #3: A Wanted Poster Scene

Preparation

Invite guests, if appropriate.

Storyline Problem

Now, how are we as detectives?

Instructional Plan

Understanding

This Lesson brings together the experience of being a detective into a summary form, a résumé that the detectives will be proud to present to their colleagues or to guests. It will also be a record of their *Detective Agency* experience that they may value in itself. The process of choosing their specialties/special skills hones a respect for his/her own accomplishments, and a sense of celebration.

The purpose is to bring together and reflect on what detecting skills have been learned, and each detective's résumé will be unique, for each detective has unique qualities, and has learned something unique from the experience of the *Detective Agency*.

Planning

Talk about the experience of "living" and "working" in a detective agency, as a class, and in small groups or vice versa. Allow time for detectives to relate stories of their own experiences here. Encourage them to think of math stories and to talk of the math in stories.

Doing

Small Group Activity:

Clock Icon showing 10 minutes. Re-show the *Detective Agency* Photo-CD, and talk about how your agency is unique. Talk about how each of the detectives, your students, have become unique detectives. All were designated a Supervisor early, and since then, throughout the detective work, many have



developed particular specialties/special skills. Allow students to discuss these possibilities in relation to themselves.



Whole Class Activity

Discuss the purpose and possible designs of a résumé.

- A résumé doesn't have in it everything you have ever done. What is your specialty/special skills; what do you do well/unique.
- It highlights what is important to you (that you have learned or can do) and why.
- How it is organized may affect its impact or what part is emphasized/noticed most.

Brainstorm and list some possible categories or titles/sections. Order them if necessary.

Select with them things they are "good" at, a few important aspects of their detective experience/skills and highlight them:

- special capabilities and experiences
- specialized skills
- special types of cases s/he is experienced with
- areas of special interest
- cases of a particular kind that s/he is good at solving, for example:
 - know how to fill out case report forms
 - how to use a video camera to take close up shots
 - able to detect convicts in disguise
 - experiences in detecting outside the agency/classroom, at home or elsewhere, good at detecting problems with my mountain bike, for example.
- use summarizing skills, decide key points, make decisions,
- think about self, and the presentation of "self" with poise and skill rather than bluntness or extreme shyness: How am I good as a detective? How can I make a case for myself "as a good detective"? How can I present this well?

Ask detectives to prepare a short talk/presentation in which they show their completed résumé and give a synopsis of it.

- Form the résumé so that it is logical, and dazzles!
- Select what they will say so it is exciting and interesting.

Encourage a range of possibilities. For example, the résumé could :

- include an example of work; how s/he would solve a case, for example.
- include letters of reference from other detectives/colleagues, the Chief Detective (Conference Reports, for example), or from other clients (if any).

The presentation could be a small quiet display where each student is given a few minutes to talk about their unique experience of detecting. They may want to tell a story of solving a particularly good or difficult case. It could take the form of an artists' portfolio.

See **Appendix A: The Security Industry** for ideas from the real-world of investigation.

Looking Back

As a closing entry in their Ask Me Logbooks, detectives might write on:

- What I liked about being a detective.
- Being a detective made me different.
- What's it like being a detective.
- Did I learn anything by being a detective?
- What do disguises have to do with Geometry?

Select materials for the ongoing class Portfolio, and organize the *Detective Agency* materials stored in the Student Folder and elsewhere into booklet form. Copy Masters Intro.B, Intro.C, Intro.D may be used as covers if desired.

Looking Ahead

Allow time (or remind) detectives to select their exemplary case and prepare a presentation of it ("science fair" fashion) for next day.

Lesson 4-2:

Case Fair/Detective Show

Duration

1 or 2 hours

Materials

You provide:

- Chart paper and felt pens

Storyline Problem

How can we present our best case to our colleagues?

Instructional Plan

Understanding

This Lesson is a celebration of being detectives. Each detective has an opportunity to share his/her best work — a case they wrote/created.

Planning

Challenge each student to make a presentation that will exemplify their best qualities as detectives. Ask them to share a case they wrote/created.

How these are shared could be discussed as well.

- in individual “booths”
- collated into a booklet, or a set of cards
- made into an exhibition and circulated
- shared with others (home, school, community). Invite guests?
- made into Case Sets and passed on to next-year’s or another Level 7 class

Doing

Detectives should solve each other’s cases.

Looking Back

Take this opportunity to talk extensively about the experience of both writing and solving detective cases — and having someone else solve your case. Share some stories or their creation and solution (written or oral).

Extension Suggestion:

Make the presentation of the résumé (previous Lesson) and the presentation of exemplary cases a celebration of the *Detective Agency*. Encourage the leaving of a legacy of detecting.

- Detectives could explore the literature for stories of detectives’ lives and/or they could write their own story.
- A detective newspaper or newsletter may be made and circulated.

Looking Ahead

Close the *Detective Agency* with whatever celebrations and clean-ups are required and, if you would like, give some hints or clues, and challenge them as the graduated detectives they are to figure out what Module/Place their classroom will become next.